The Iron Ores of Lake Superior

THE IRON ORES OF LAKE SUPERIOR

CONTAINING SOME FACTS OF INTEREST RELATING TO MINING AND SHIPPING OF THE ORE AND LOCATION OF PRINCIPAL MINES

FOURTH EDITION

WITH ORIGINAL MAPS OF THE RANGES

BY

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CHEMISTS AND METALLURGISTS

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PREFACE

This is the fourth revised edition of The Iron Ores of Lake Superior, and is issued in response to the demand for up-to-date information in regard to the development and present status of mining properties, and the iron ore mining industry in general.

New chapters have been introduced, presenting the average analyses of all the iron ores of the Lake Superior district since 1902, and describing modern methods for mixing ores, while other chapters have been rewritten to conform with records and statistics since the publication of our third edition in 1917. All of the data relating to mines have been brought up to 1920.

It is a pleasure to acknowledge the assistance given us in the preparation of this book by many companies and individuals identified with the mining industry. They have co-operated with us toward continuing this as a standard reference work, and we trust that the fourth edition will prove as useful as those preceding.

Crowell & Murray.

Cleveland, July 1, 1920.

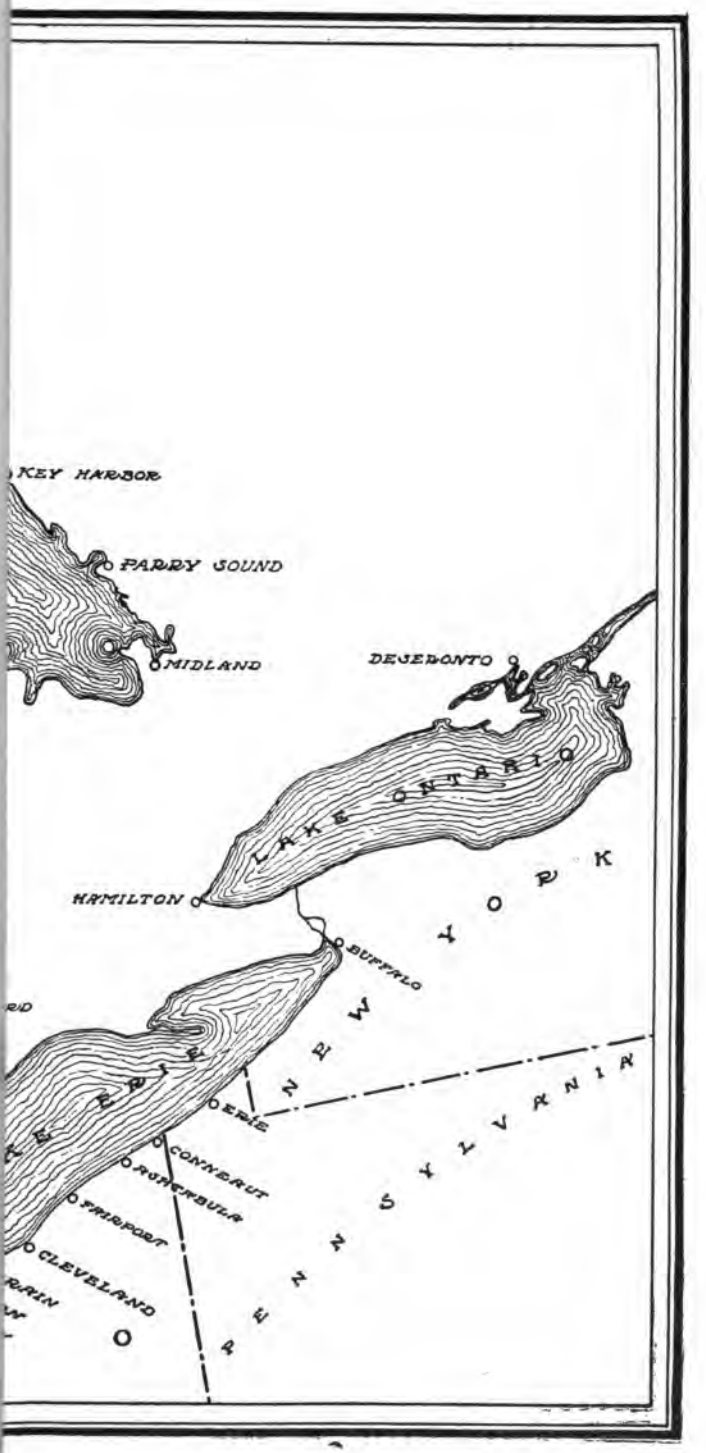
CONTENTS

CONTENTS—*Continued*

CHAPTER X

CHAPTER XI

CHAPTER XII


KEY HARBOR
PARRY SOUND
MIDLAND
DESERONTO
LAKE ONTARIO
HAMILTON
BUFFALO
NEW YORK
ERIE
PENNSYLVANIA
CONNEAUT
ASHTABULA
FAIRPORT
CLEVELAND

Chapter I.

THE EARLY HISTORY OF THE LAKE SUPERIOR REGION

The early history of the Lake Superior iron ore region has been written by many able historians, and it is not within the scope of this book to give more than an outline of this very interesting subject.

In 1816 the United States government began a careful survey of the government lands in the Northwest Territory. The system adopted was simple and is based on the well-known method of determining points by rectangular co-ordinates, the original being the intersection of two lines run at right angles. One line, extending north and south, is called the principal meridian, and the other, extending east and west, is called the base line. The land is laid out in townships, each six miles square and designated by a number, north or south, depending on whether they are north or south of the base line. The lines running north and south dividing the townships are called range lines, and the territory between two of these lines is known as a certain number, east or west, as the case may be, from the principal meridian. The townships are divided into 36 sections, each of which is one mile square. Each section is divided into four parts, each part known as a quarter-section and containing 160 acres.

There were many legends among the Indian inhabitants of the Upper Peninsula regarding the presence of "hard rock" in various parts of the country, and the first white settlers were more or less familiar with these stories. It was not until 1844, however, that a party of United States government surveyors really located the first iron ore in Michigan. In the course of their work they noticed the variation of their magnetic needle, and finally discovered iron ore near Teal Lake. This discovery, however, did not attract much attention. The Jackson Iron Co., of Jackson, Mich., in 1847, after many difficulties started a forge on Carp river, five miles east of Negaunee, and made the first iron in the Lake Superior region in February, 1848. This forge was operated spasmodically for some years, its greatest production being three tons a day.

In the early fifties the Lake Superior iron ore began to attract attention in Pennsylvania, and on July 7, 1852, six barrels of ore were shipped to New Castle in that state. This was the first shipment of Lake Superior iron ore to lower lake ports. It was not until 1856, however, that the Marquette range began to ship ore regularly. These shipments were made possible by the opening of the ship canal around the rapids at Sault Ste. Marie, in 1855. This canal was constructed under great difficulties and with much opposition from the Congress of the

United States. As the interest in Lake Superior ores increased, further discoveries were made. In 1873 ore was found on the Menominee range, which lies about 50 miles south of the Marquette range, and in 1877 ore began to be shipped from this range. The first actual cargo, however, was shipped from Milwaukee, Nov. 11, 1884.

In 1883, ore was found in paying quantities at the Colby mine, on the Gogebic range. This range lies about 100 miles west of the Marquette range, and in 1884 became a regular shipper of ore. At about the same time, iron ore was discovered on the Vermilion range, which lies in the northeastern part of Minnesota about 100 miles north of Duluth. In 1884 this range became a shipper.

About 30 miles southwest of the Vermilion range is the Mesabi range, which extends in an east and west direction for approximately 100 miles. The eastern end of the range lies between Duluth and the Vermilion range, and the early exporation on the range was mostly confined to this portion, which was not productive. In 1890, however, ore was discovered just north of what is now known as the Mountain Iron mine, and this discovery was rapidly followed by others. This range has become the largest shipper of ore of any of the Lake Superior ranges, owing to the large bodies of ore present, and the ease with which it can be taken out. The Cuyuna range, which is also in Minnesota, about 90 miles west of Duluth, is the youngest range in the Lake Superior region. In 1904 a low grade magnetite ore was discovered near Deerwood, and later hematite deposits were shown to exist. In 1911 this range began to ship ore and its present prospects are good for becoming a large shipper.

The state of Wisconsin ships considerable iron ore from the Baraboo district. This district is located south of the central part of Wisconsin. Ore was first discovered here in 1900, and in 1904 the district began regular shipments.

On the Canadian shore of Lake Superior, and in the adjacent territory, there are large areas of iron-bearing formation similar to those found on the American side, but as yet most of the exploration in these areas has been disappointing. The oldest productive range in Canada, and the largest shipper, is the Michipicoten range, which lies on the northeastern shore of Lake Superior, northeast from Michipicoten Island. This range was first opened up in 1897, as a gold-mining district, but soon became far more valuable as an iron range. The Helen mine has been a shipper from this range since 1900. The only other producing mine on the range, the Magpie mine, made its first shipment in 1913. The Moose Mountain district is located about 30 miles north of Sudbury, Ont. It was first opened up in 1902. The only mine at present on this range is the Moose Mountain mine, which began shipping in 1908.

Chapter II.

GEOLOGY

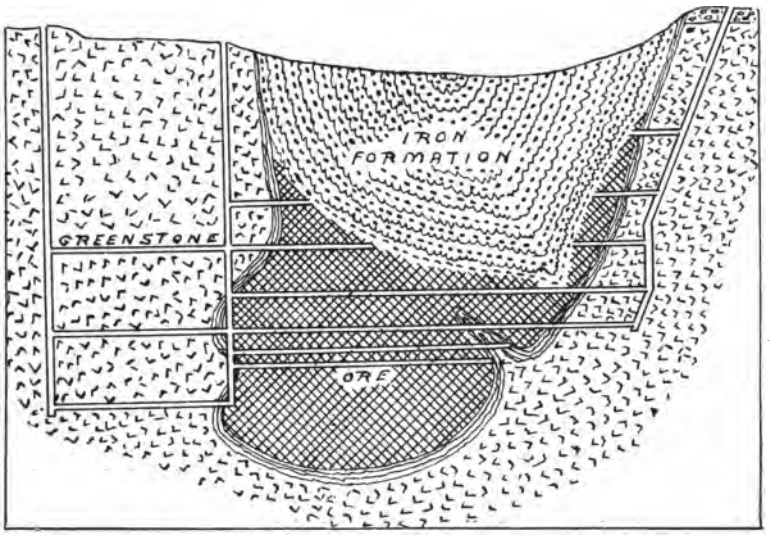
The Lake Superior region is located in Michigan, Wisconsin, Minnesota and Ontario. It contains approximately 181,000 square miles, and is located near the headwaters of three great drainage systems. The largest part of the area is drained by waters that are tributary to Lake Superior and Lake Michigan and thence to the St. Lawrence river. On the west a part of the area is drained by the headwaters of the Mississippi river and on the north a part of the area is drained by the waters that flow into Hudson bay. The drainage of the region, however, is very imperfect and it is characterized by numerous small lakes and swamps or muskegs and swift running streams. The surface varies from 602 feet above sea level at Lake Superior to 2,230 feet in Northeastern Minnesota, but it usually lies between 1000 and 1700 feet above sea level.

The principal topographic feature of the region is the Lake Superior basin. This trends in an easterly and westerly direction, and except along the southeastern margin is nearly walled in by steep escarpments that rise 400 to 800 feet above the surface of the lake. In the adjacent areas the principal ridges and valleys usually trend parallel to the lake. Along the southeastern margin the shore is usually flat and the adjacent area is low lying. The surface of the whole region is mostly covered with a varying thickness of glacial drift, and soil that has resulted from the decompositions of the underlying rocks is very seldom found.

The iron bearing districts lie at an average elevation of about 1500 feet above sea level. They contain approximately 3800 square miles, or about 2 per cent of the total area of the region. They have been closely studied and the principal geological features in each district have been identified. The intervening areas are not so well known. The region is a part of the southern margin of the great pre-Cambrian area in the northern part of North America. It is bordered and overlapped on the south by Palezoic rocks of the Mississippi valley, and on the southwest by Cretaceous deposits. The pre-Cambrian rocks include the oldest rocks on the North American continent. They are divided geologically into rocks belonging to two systems known as the Archean, or basement complex, and the Algonkian. The Archean system is the oldest and is divided into two series known as the Keewatin and the Laurentian. The Keewatin series is made up of certain basic igneous rocks known as green stones and green schists, which are associated with subordinate amounts of iron formation, slates and dolomite. They are the oldest rocks in the Lake Superior region.

Intrusive into these rocks are certain granites, gneisses and syenites that belong to the Laurentian Age, and superimposed upon them are rocks belonging to the Algonkian system. This system is

made up of four sedimentary series which are closely associated with igneous rocks. The three lower series, known as the Lower, Middle and Upper Huronian, consist of iron formations embedded with slate and quartzite. The upper series, known as the Keweenawan, con-



Vertical Section through Vermilion Ore Deposit and Adjacent Rocks

sists of conglomerates, sandstones, shales and limestones associated with both basic and acid igneous rocks. It contains no iron formations, but forms the copper-bearing series of Michigan.

The iron formations occur in both the Keewatin and the Huronian series of rocks. They are all very similar, and consist of chert or quartz, ferric oxide and small amounts of other iron-bearing materials. They represent more or less altered sediments that were derived from rocks rich in iron. This alteration has been due to the chemical action of underground water, and where it has been extensive, the iron formation has been decomposed and ore deposits have been formed. The most important factors in this connection are the structural relations of the iron formation and the presence or absence of impervious rocks at the base, or embedded within the iron formation. These factors have controlled the flow of the underground water, and consequently, the alteration of the iron formation.

As a general rule, the ore deposits are found on the slopes or at the base of conspicuous ranges or hills, and are associated with pitching troughs of relatively impervious rocks. These troughs may be formed by greenstone as on the Vermillion range, by layers of slate within the iron formation, as on the Mesabi range, or by the intersection of slate or quartzite and igneous dikes, as on the Gogebic range. Where the troughs are large and uniform, the alteration

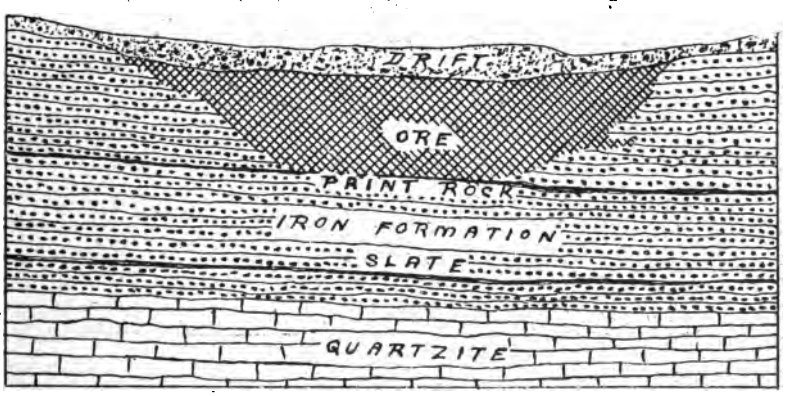
of the iron formation has been extensive and large deposits of ore have been formed. Where they are small, irregular or broken, the alteration has been less extensive and the ore deposits are small. The ores were deposited in a hydrated condition, but have been partially dehydrated and may be classified as red, blue and micaceous hematite and magnetite. The soft ores are hematite and limonite. An outline of the principal features of each district is as follows:

Vermilion range: The Vermilion district lies in Northeastern Minnesota, and includes the towns of Tower, Soudan and Ely. The productive formation is the Soudan in the Keewatin division of the Archean. It occurs in narrow belts which are enclosed in greenstone. The whole district is one of complex folding. The ores are hard, blue and red hematites. They occur at or near the contact of the Soudan formation with the greenstone, and owing to the steep pitch, the outcrops are small.

The depths of some of the mines are as follows: Pioneer, 1,466 feet; Sibley, 1,285 feet; Soudan, 2,707 feet; Zenith, 1,102 feet.

Mesabi range: The Mesabi range lies in Minnesota, northwest of Lake Superior, and extends in an east and west direction approximately 100 miles. The principal towns are Biwabik, Eveleth, Virginia, Chisholm, Hibbing, Nashwauk and Coleraine.

The iron formation is the Biwabik in the Upper Huronian. It lies along the southern slope of a ridge that is known as the Giants or Mesabi range, and has a gentle slope toward the south. The surface is covered with glacial drift, and rock exposures are not



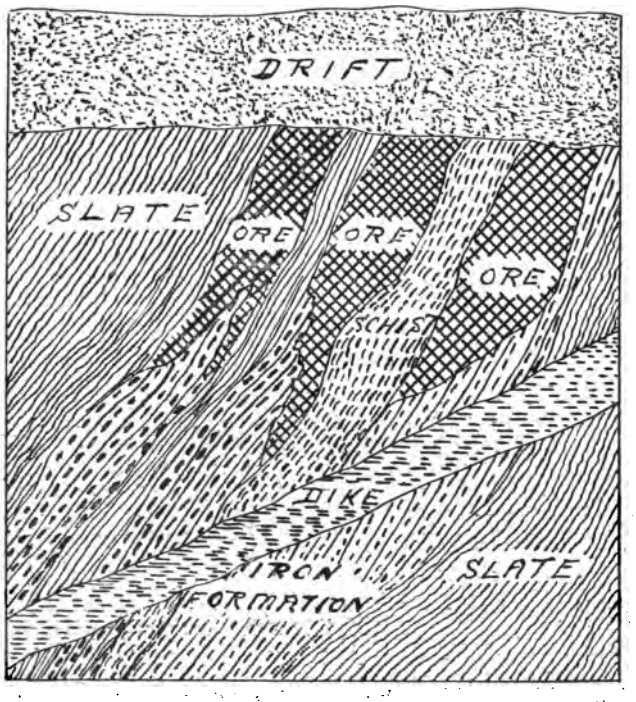
General Vertical Section through Mesabi Ore Deposit and Adjacent Rocks

common. The slope of the iron formation is gentle, and the ore deposits are mostly flat lying and have a large horizontal area compared with the deposits on the other ranges. As a general rule, the ore is covered only by glacial drift, and the characteristic method of mining on the range is by open pit. The impervious basement

under the ore deposits is formed by layers of slate or paint rock, interbedded with the iron formation.

The ores are mostly soft and hydrated hematites and limonite. They vary in texture from very fine dust to fairly coarse, hard and granular ore. Toward the western end of the district, layers of sand are often found interbedded with the ore forming the so-called "sandy" ores which will require concentration to form ore of commercial grade.

The Mesabi ore deposits are shallow. The depths of some of the mines are as follows: Albany, 260 feet; Chester, 251 feet; Fayal, 428 feet; Hawkins, 125 feet; Madrid, 132 feet; Woodbridge, 255 feet.



Generalized Vertical Section through Cuyuna Ore Deposit and Adjacent Rocks

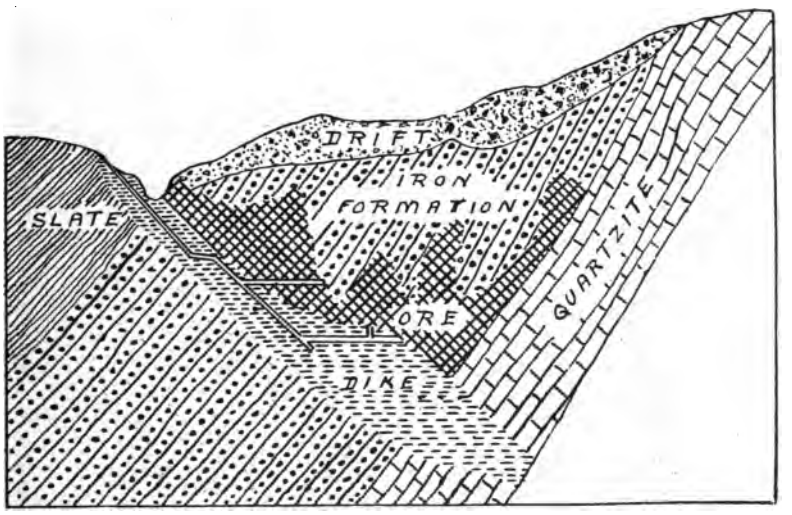
Cuyuna range: The Cuyuna range is located in Crow Wing county, Minn., approximately 100 miles west of Duluth. The principal towns are Deerwood, Crosby and Brainerd.

This range has no marked topographic features, such as characterize the other Lake Superior iron ranges. The surface is level, and is covered with a heavy mantle of sand, and there are few

boulders such as appear on other Lake Superior ore ranges. The drainage is into the Mississippi river.

There are no surface indications to assist in the exploration for ore, which is almost altogether dependent upon the presence of lines of magnetic variation. By drilling, these lines have been found to be associated with belts of iron-bearing formations which trend in a northeasterly and southwesterly direction. The formation is interfoliated with slate and schist, and is usually steeply tilted. At some localities igneous intrusive rocks occur. The iron formation probably belongs to the Upper Huronian series of rocks, and occurs in two more or less parallel belts known as the North and South ranges, and the ore deposits are usually lenticular in form.

The depths of some of the mines are as follows: Adams, 207 feet; Croft, 333 feet; Mahnomen, 250 feet.



Generalized Vertical Section through Gogebic Ore Deposit and Adjacent Rocks

Gogebic range: The Gogebic range is a narrow belt of iron formation which lies south of Lake Superior in Michigan and Wisconsin. The most important part of the district lies in Michigan, although about two-thirds of the formation extends into Wisconsin. The most important towns are Wakefield, Bessemer, Ironwood and Hurley.

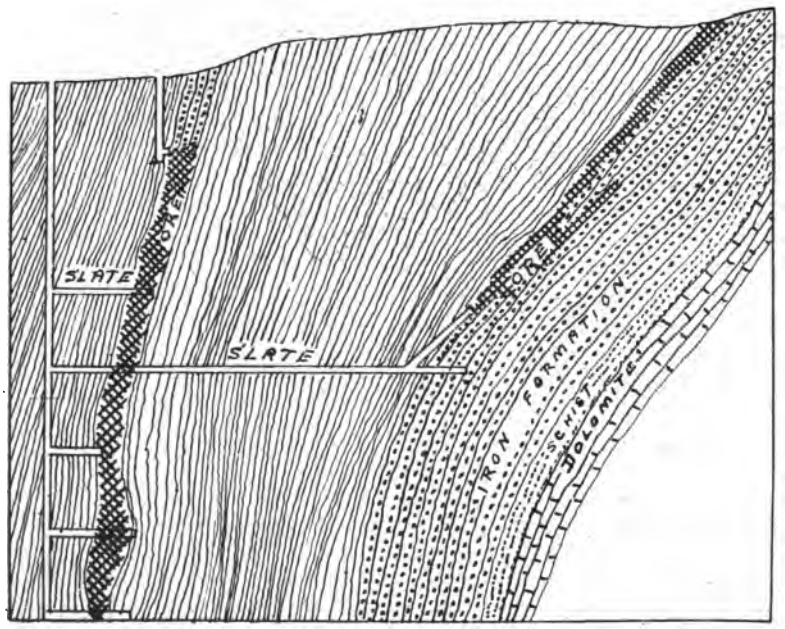
The productive formation is the Ironwood in the Upper Huronian series. It occurs as a narrow belt which dips toward the north and has a crenulated outcrop, due to a series of minor transverse rolls. The formation rests on Upper Huronian quartzite, and is cut by igneous dikes, which combine with the quartzite to form

impervious troughs in which the ore bodies were concentrated. The ores are soft, red and partially hydrated hematites, with subordinate amounts of hard, blue hematite.

The depths of some of the mines are as follows: Anvil, 1,600 feet; Brotherton, 1,342 feet; Cary, 1322 feet; Newport, 2,300 feet; Norrie-Aurora, 1,870 feet; Sunday Lake, 1,494 feet; Tilden, 2,095 feet.

Iron River, Crystal Falls and Florence districts: The Iron River and the Crystal Falls districts lie in Michigan and the Florence district in Wisconsin. The principal towns are Iron River, Crystal Falls and Florence. The iron-bearing formations occur in the Upper and Middle Huronian and are respectively known as the Michigamme and the Negaunee formations. The ores are mostly soft, red hematites, although in places, they are hydrated and classified as limonite. The district is usually included with the Menominee district in the figures for the production of iron ore.

The depths of some of the mines are as follows: Bristol, 1,274 feet; Baltic, 553 feet; Florence, 700 feet.

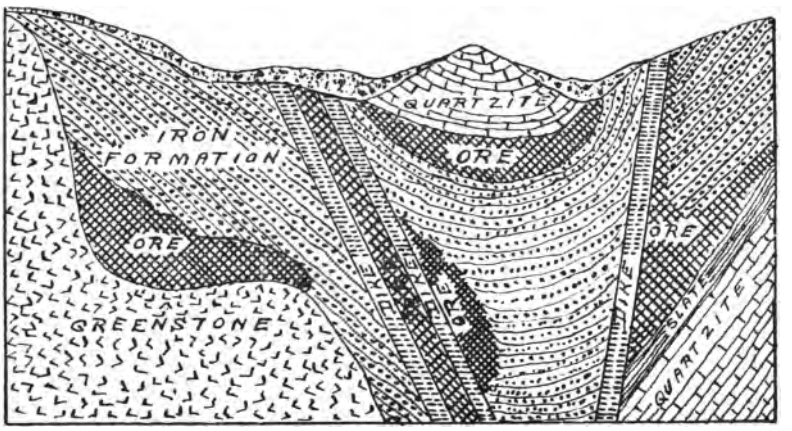


Generalized Vertical Section through Menominee Ore Deposit and Adjacent Rocks

Menominee range: The Menominee district includes the towns of Iron Mountain and Norway. It lies wholly in the state of Michigan. The productive iron formation is the Vulcan in the Upper Huronian series. It occurs in several arrow belts, all of

which have a steep dip. The principal belt extends about 20 miles in an east and west direction. The formation, where productive, rests on the Lower Huronian dolomite, and is covered by Upper Huronian slate. The Middle Huronian series has not been identified in the district. The ores are usually bluish-black hematites, though subordinate amounts of red and brown, banded hematites are found.

The depths of some of the mines are as follows: Amasa Porter, 696 feet; Chapin, 1,522 feet; Judson, 550 feet; Penn Mine, 1,500 feet.



Generalized Vertical Section through Marquette Ore Deposit and Adjacent Rocks

Marquette range: The Marquette district is comparatively small. It lies in the state of Michigan and derives its name from the city of Marquette. The principal towns are Ishpeming, Negaunee, Champion and Republic.

The iron formation occurs in the Upper and Middle Huronian and the Keewatin division of the Archaen. The productive formations are the Negaunee in the Middle Huronian, and the Ishpeming in the Upper Huronian. The ores are mostly soft, red hematites, although the hard, micaceous hematites are important. Subordinate amounts of magnetite and limonite are found. The district is cross-folded, so that the formations are irregularly distributed. In general, the iron formation extends in an east and west direction, and the portions of the ore deposits that reach the surface are located on the middle or upper parts of the slopes.

The outcrops of ore were conspicuous and led to the early discovery of this district. Some of the bodies are entirely below low-lying areas, but in those cases, are surrounded by impervious rocks.

The depths of some of the mines are as follows: American, 1,850 feet; Cambria, 1,300 feet; Lake Superior, 1,247 feet; Maas, 1,375 feet; Republic, 2,470 feet; Salisbury, 1,120 feet; Washington, 730 feet.

Baraboo district: The Baraboo district is an outlier of the Lake Superior pre-Cambrian rocks, and is located in south-central Wisconsin. The principal town is North Freedom. The iron formation is similar to the Middle Huronian, but has not been positively identified. The ores are hematites with soft, earthy, hard and black and banded silicious phases. They are stratified and have the same strike and dip as the associated rocks which are found dipping at various angles from nearly horizontal to nearly vertical.

Michipicoten range: The Michipicoten range lies in Ontario, Can., on the Northeastern shore of Lake Superior. The only productive mines are the Helen and the Magpie. The iron formation is in the Keewatin series of the Archean. The ore at the Helen mine is a hard, red, nonbessemer hematite. At the Magpie mine it is siderite, and is calcined and sintered to produce a commercial product. The depth of the Magpie mine is 581 feet.

Moose Mountain district: The Moose Mountain district is in Ontario, Can., 33 miles north of Sudbury. The ore occurs in the Keewatin division of the Archean. It is mostly finely crystalized magnetite, which contains a little hematite. It contains no high-grade ore, but material which is necessary to concentrate. The ore is mined by both open cut and underground methods.

Chapter III.

MINERALOGY

The principal iron ores found in the Lake Superior region are hematite, limonite, magnetite and siderite. Turgite and goethite are commercially included with limonite. The residues from roasting the sulphides for the manufacture of sulphuric acid are sometimes used as a source of iron, and some ilmenite is smelted with other ores. The minerals described are:

Oxides		
	Hematite, Fe_2O_3	Hexagonal
	Magnetite, Fe_3O_4	Isometric
	Martite, Fe_2O_3	Isometric
	Ilmenite, $(FeTi)_2O_3$	Hexagonal
	Pyrolusite, MnO_2	Orthorhombic
Hydroxides		
	Limonite, $Fe_2\ (OH)_6Fe_2O_3$	
	Turgite, $Fe_4O_5(OH)_2$	
	Goethite, $FeO\ (OH)$	Orthorhombic
	Manganite, $Mn_2O_3(H_2O)$	Orthorhombic
	Psilomelane, $(K_2BaMn)OMnO_2$	
	Wad	Composition variable
Carbonates		
	Siderite, $FeCO_3$	Hexagonal
	Rhodochrosite, $MnCO_3$	Hexagonal
Silicate		
	Rhodonite, $MnSiO_3$	Triclinic
Sulphides		
	Pyrite, FeS_2	Isometric
	Pyrrhotite, Fe_6S_7 to $Fe_{11}S_{12}$	Hexagonal
	Marcasite, FeS_2	Orthorhombic

HEMATITE

Composition: Fe_2O_3, contains 70 per cent iron.

Description: Occurs in masses which are compact, granular, or sometimes micaceous and as loose pulverulent earth. It varies in color from brilliant black metallic to brick red. In all varieties the streak on porcelain is red. The hardness varies from 5.5 to 6.5 and the specific gravity from 4.9 to 5.3.

MAGNETITE

Composition: Fe_3O_4, contains 72.4 per cent iron.

Description: A black mineral with a black streak on porcelain, and metallic lustre, strongly attracted by the magnet and occurring in all conditions from loose sand to compact, coarse or fine grained masses. The hardness varies from 5.5 to 6.5 and the specific gravity from 4.9 to 5.2.

MARTITE

Composition: Fe_2O_3, contains 70 per cent iron.

Description: Differs from hematite in nothing but form. It occurs in octahedrons which it is supposed were derived from the oxidation of magnetite.

ILMENITE (Iron Titanium Compound)

Composition: $(FeTi)_2O_3$, Composition varable.

Description: An iron black mineral usually massive, and in thin plates, imbedded grains or as sand. The streak on porcelain is black to brownish red. The hardness varies from 5 to 6 and the specific gravity from 4.5 to 5.

PYROLUSITE

Composition: MnO_2, contains 63.2 per cent manganese.

Description: A soft manganese ore that occurs granular or massive in more or less radially grouped or parallel bundles of fibres. It varies in color from iron black to dark steel gray, and soils the hands. The streak on porcelain is black or bluish-black. The hardness varies from 2 to 2.5 and the specific gravity is 4.8.

LIMONITE

Composition: $Fe_2(OH)_6Fe_2O_3$, contains 59.8 per cent iron.

Description: Varies from loose porous bog ore and ochre to compact varieties, which often have a black varnish-like surface and a fibrous, radiated structure. It is recognized principally by its yellowish brown streak on porcelain and absence of crystallization. The hardness varies from 5 to 5.5 and the specific gravity from 3.6 to 4.

TURGITE

Composition: $Fe_4O_5(OH)_2$, contains 66.2 per cent iron.

Description: Nearly black and resembles limonite but has a brownish red streak on porcelain. The hardness varies from 5.5 to 6 and the specific gravity from 4.3 to 4.7.

GOETHITE

Composition: $FeO(OH)$, contains 62.9 per cent iron.

Description: A yellow, red or brown mineral occurring in distinct crystals often flattened, like scales, or needle-like and grouped in parallel position; also, occurs massive like yellow ochre. The streak on porcelain is yellow, or brownish-yellow. The hardness varies from 5 to 5.5 and the specific gravity from 4 to 4.4.

MANGANITE

Composition: $Mn_2O_3(H_2O)$, contains 62.5 per cent manganese.

Description: A dark, steel-gray or black mineral with submetallic lustre. It occurs massive and in rhombic prisms which are striated longitudinally. The streak on porcelain is reddish or sometimes nearly black. The hardness varies from 4 to 4.5 and the specific gravity from 4.3 to 4.4.

PSILOMELANE

Composition: $(K_2BaMn)OMnO_2H_2O$, manganese contents variable.

Description: A hard, massive black or greenish-black mineral that usually occurs associated with pyrolusite. The streak on porcelain is reddish or brownish black. The hardness varies from 5 to 6 and the specific gravity from 4 to 4.4.

WAD (Bog Manganese)

Composition: Contains 20 to 45 per cent manganese and 10 to 25 per cent combined water, with varying amounts of oxides of iron, cobalt and copper.

Description: It is formed in low places, from the decomposition of minerals, containing manganese. It occurs massive or earthy and varies in color from dull to bluish or brownish-black. The streak on porcelain is black or brownish-black. The hardness varies from 1 to 6 and the specific gravity from 3 to 4.

SIDERITE

Composition:. $FeCO_3$, contains 48.2 per cent iron.

Description: Occurs in granular masses of a gray or brown color, or may be black from included carbonaceous matter. The lustre is vitreous to pearly and the mineral is brittle. The streak on porcelain is white or pale yellow. The hardness is 3.5 to 4 and the specific gravity 3.8 to 3.9.

RHODOCHROSITE

Composition: $MnCO_3$, contains 47.8 per cent manganese.

Description: Varies in color from rose red to yellowish-gray and brown, and in lustre from vitreous to pearly. It occurs crystallized and also granular and massive. The streak on porcelain is white. The hardness varies from 3.5 to 4.5 and the specific gravity from 3.4 to 3.7.

RHODONITE

Composition: $MnSiO_3$, contains 41.9 per cent manganese.

Description: Usually occurs massive and varies in color from red to brown, green or yellow when pure. The streak on porcelain is white. The hardness varies from 5.5 to 6.5 and the specific gravity from 3.4 to 3.7.

PYRITE

Composition: FeS_2, contains 46.7 per cent iron, 53.3 per cent sulphur.

Description: A brass colored metallic mineral, frequently in cubic or other isometric crystals, or in crystalline masses, less frequently in non-crystalline masses. The streak on porcelain is greenish-black, the hardness 6 to 6.5 and the specific gravity 4.9 to 5.2.

PYRRHOTITE

Composition: Fe_6S_7 to $Fe_{11}S_{12}$, composition variable.

Description: Usually a massive bronze metallic mineral which is attracted by the magnet and can be scratched with a knife. The streak on porcelain is grayish-black, the hardness 3.5 to 4.5 and the specific gravity 4.5 to 4.6.

MARCASITE

Composition: FeS_2, same as pyrite.

Description: Differs from pyrite in nothing but form. Crystallizes in orthorhombic forms which have received the names of cockscomb pyrites, spear pyrites, etc. The streak on porcelain is nearly black, the hardness 6 to 6.5 and the specific gravity 4.6 to 4.9.

Chapter IV.

DRILLING, EXPLORING, MINING

Exploration for iron ore is as much an engineering problem as mining the ore after it is found. There is, however, a difference between exploration and drilling. Efficiency in exploration means more than a high footage rate per day or a low cost per foot; it concerns every step in the operation from the time a property is first considered as an exploring possibility until the last ore estimate is made or the property abandoned. At no place is there room for haphazard methods or guesswork. That mining companies to a large extent appreciate this is evidenced by the number whose exploration work is placed under the direction of geologists and engineers, while certain exploration companies, doing contract work, employ geologists whose assistance in the interpretation of the drilling records add greatly to the value of the information submitted to a client.

The earliest exploration in the Lake Superior iron districts was by means of trenches, test pits and shafts. The few ore bodies which outcrop at the surface were found at comparatively early dates, and as the necessity for deeper and more rapid exploration arose, diamond and churn drills were brought into use; the churn drill being a development of the Mesabi range. The first diamond drilling was done in 1877 near Ishpeming, Mich., on the Marquette range, followed soon after by work on the Vermillion range in Minnesota and the Menominee and Gogebic in Michigan. On all of these ranges the ore is found to extend to considerable depth, and deep holes, both vertical and angle, are drilled.

The first drill was placed on the Mesabi in 1890, previous exploration having been by test pitting. Flat-lying, comparatively shallow formations, as on this range, result in vertical holes of moderate depths. On the Cuyuna range exploration has been entirely by the churn and diamond drill. Both vertical and angle holes are drilled, averaging 300 feet in depth.

Present methods are the result of over 25 years' experience in which all phases of the subject have been studied from an engineering standpoint. The results are, as a whole, reliable and the cost comparatively low. In drilling through the surface and in soft formations, the churn drill is used. The cutting is done by percussion instead of by rotation as in the diamond drill. A chisel-shaped bit is used, having perforations near its cutting edge, while the upper end of the bit is threaded and screwed to the line of drill rods, which consist of extra heavy pipe. At their upper ends the rods are connected to the pump by a flexible

coupling and water is forced down through the rods and out of the perforations in the bit, coming up between the rods and the casing pipe and carrying the cuttings to the surface. The churning motion of the rods and bit is secured by passing a rope from the upper end of the line of rods through a sheave wheel in the tripod and down again, winding it two or three times around the drum of the churn drill engine, the end being left loose. The drill runner alternately tightens and slackens this rope while the drum is revolving, thus raising and dropping the bit, the rods being turned slightly after each stroke.

In surface drift a 3-inch casing pipe is ordinarily used. Sometimes in deep surface a 4½ or 5-inch pipe is used, but it is better wherever possible to use the 3-inch and make every effort to carry it through the surface. The casing is driven down by a cylindrical cast iron hammer or drive block weighing from 250 to 350 pounds. When boulders of any size are encountered they are broken up with dynamite, the casing being raised far enough to be out of danger. An electric battery is used to set off the charge. On the Mesabi and Cuyuna ranges most of the ores are soft and are churn drilled. If soft ore is found immediately below the surface, the 3-inch casing is driven a little way into it and stopped, continuing in the ore with a 2-inch casing. If the same casing is used in ore as in the surface, fine sand is likely to run down along the pipe and destroy the sample.

In diamond drilling a line of hollow rods is screwed together, usually in 10-foot lengths, and rotated by an engine through a shaft and gearing. At the bottom of the line of rods is a bit, an annular piece of steel in which are set pieces of carbon otherwise known as black diamonds. The bit is fed forward by means of a screw feed or a piston working in a hydraulic cylinder. As the bit advances it cuts an annular hole, usually 1 9/16 inches in diameter, leaving a 15/16-inch core. Water is forced down through the rods carrying the cuttings away from the bit and to the surface. The core is forced into the lower rod, known as the core barrel, and held there by the core shell and spring and brought to the surface when the rods are pulled. Holes are drilled from surface either vertically or at an angle; from underground horizontally or at any angle either up or down.

Samples or ore are taken at 5-foot intervals. In general churn drill samples are collected in barrels, four being used, while the cuttings from diamond drilling are caught in some form of a rectangular box, usually divided into three compartments by baffle plates. Sampling is one of the most important parts of exploration and too much attention cannot be given to it.

When it has been decided to start exploration, it is advisable to have the property examined by a geologist, who cruises over

the land noting the presence and character of outcrops, locating old drill holes and test pits and taking dip-needle readings. This, perhaps, is not so important on the Mesabi range where the limits of the iron-bearing formation are well defined, but even here the possibility of finding old drill holes or test pits makes it advisable to have the property examined before drilling is started. Too much drilling is done without taking the fullest advantage of all available knowledge.

The proper interpretation of drilling records is of utmost importance. It seems evident that to secure the best results the samples should be examined, the holes stopped and new locations given by one who has at least some knowledge of the geology of the district, but this is not always done. Too often the drill runner classifies the materials encountered and the samples are not permanently preserved. As long as a person or company retain their interest in a property, the samples from their drilling should not be destroyed. The larger exploration companies provide for fire-proof storage of samples at no cost to their clients, a service which should be utilized. It is certain that less money would be wasted and a higher percentage of success in exploration secured if proper construction were placed on results of drilling.

The iron deposits of the Lake Superior region show great variations as to the character and accessibility of the ore. In some places the ore is very hard and difficult to mine and in other places it is very soft. In some places it is found close to the surface and can be mined by surface methods, and elsewhere it occurs at great depths and must be mined by underground methods. In any case, however, carefully planned systems of mining are permitted, due to definite information as to the location and size, form and grade of the ore body from exploration, previous to actual operations. Such exploration is done by drilling and is of the utmost importance in the successful development of a property, as it furnishes the basis for all subsequent operations. The methods of drilling and of recording exploration results have been carefully systematized and as a general rule, estimates based on these records prove remarkably accurate. These methods are described elsewhere in this book.

Compared with other iron ore districts, the Lake Superior region has great natural advantages, as the ore deposits are large and comparatively high grade, and the occurrence is such in a great many cases, as to make them readily accessible for mining. This is especially true for the Mesabi range, where the characteristic occurrence of the ore is in shallow troughs, which have a large horizontal area. As a general rule, these deposits are covered only by glacial drift, and the characteristic method of

mining is by steam shovel, although a considerable amount of ore is mined on this range, by underground methods.

Mining methods on the Mesabi range may be divided into two general classifications, surface and underground. The ores are characteristically soft and friable, and the occurrence is such that exploration is comparatively cheap and effective. The method of mining used depends on the thickness of the overburden, the size, shape and uniformity of the ore body, the facilities for approaching the ore body by open cut, the space available for dumping the overburden and the money available for stripping. These factors are determined previous to actual operation, and the propriety determined of mining by surface or underground methods. If possible, steam shovel operation is given the preference over underground methods of mining, unless the amount of overburden is too great compared with the amount of ore available. At the present time, the economical limit of stripping is generally considered to be one yard of overburden to one ton of ore where the vertical depth of the overburden does not exceed two feet of stripping to one foot of ore. The character of the overburden must also be taken into consideration, and allowance made for difficult stripping, and in any case, approximately 150 feet is taken as the maximum depth of overburden that can be economically removed.

Mining ore by steam shovel has reached a high state of development on the Mesabi range. The system is simple, but the procedure is often complicated by internal and external factors that cause irregular operation in the pit and fluctuations in the cost of mining. The ore deposits are often irregular in form and grade, and the track arrangement and shovel operations are often subject to considerable variation to meet individual conditions, and to produce the grades of ore desired. Steam shovel operation, however, has many advantages over underground systems of mining, and if the estimated cost of mining by this method is equal to or even slightly exceeds the estimated cost of mining by underground methods, it is usually chosen as the most desirable method of operation. Mines operated by steam shovels are capable of large outputs per day, and the tonnage produced per man employed is very much greater than is possible by underground methods, so that large productions can be maintained with a comparatively small operating crew. Steam shovel operation also has the advantage that the production can be quickly increased or decreased to conform with market conditions, and that if desired the property so operated can remain idle during periods of depression without heavy charges for maintenance and operations quickly resumed without especial preparation or expense.

The underground methods used on the Mesabi range consist of caving systems that allow the surface to settle as the ore beneath is removed. The method most commonly used is known as the top slicing system, and is subject to various modifications to meet individual conditions. The underground development essentially consists of a shaft, shaft station and pump room, a main haulage level and raises, drifts and cross cuts on the sub-levels. As much as possible of this work is done in ore. In mining, raises are put up to barren or caved ground and drifts are run in ore from the tops of the raises, parallel to the main drifts below. These drifts are extended until they reach the limits of the ore body or barren ground that has already been caved. Cross cuts are then driven from the ends of the drifts to the limits of the ore body, and a mat of timber is laid on the floor. The timbers supporting the cross-cuts are then blasted out and the overburden is allowed to cave. This process is repeated until the pillars are entirely removed and work on a new slice is begun, and is continued until the entire deposit has been mined. The system is adapted to mining large deposits where steam shovels cannot be employed. The advantages of the method over other methods of underground mining are that the cost of mining is low, and the percentage of ore extracted is high. The development is simple and the opportunity is given for sorting ore and keeping various grades separate. The disadvantages are that the number of working places is limited, and consequently the production is curtailed. Considerable timber is required and the timber and ore both require considerable handling.

A combination of surface and underground methods of mining known as the milling system, is sometimes used. In this system the surface is stripped as in steam shovel mining, and the ore is broken and falls into mills or raises that extend to the surface from underground workings. The ore is then transported to the shaft, and is hoisted as in the underground method.

On the other ranges the ore deposits occur at such depths that surface methods of mining can be used in only a few isolated cases. These methods are similar to those already described for the Mesabi range. In most cases underground methods of mining must be resorted to and the ores are usually hoisted from depths that vary from 500 to 1500 feet, although in some cases, the mine workings extend to a vertical depth of 2,200 feet or more and are still in ore. The methods used depend on the size, form and attitude of the ore bodies, and the character of ore. They may be divided into two general classifications, caving and stoping methods.

The caving methods of mining are best adapted to deposits having a comparatively large horizontal area, and consist of top

slicing, sub-drifting and various modifications to meet individual requirements. The top-slicing system is generally used with ores that are more or less mixed in grade and comparatively easy to cave, while the sub-drift system of mining is used with harder formations and ores of uniform grade, as it is difficult to separate various grades of this system. The development outside of the ore body is the same in either system of mining. Shafts are sunk some distance from the ore deposits, and permanent haulage ways are driven in solid rock to the ore deposit. The method of procedure then with the top slicing system, is the same with some modifications, as that previously described for the Mesabi range.

In the sub-drift system of mining the main levels are driven near the walls of the deposit and drifts are driven at intervals cross-cutting the deposit. Raises are then put up and sub-drifts are driven parallel to the drifts on the main level until the raises break through into the level above and the sub-drifts have been connected with other sub-drifts. By this means, the ore between the two main levels is honeycombed with vertical and horizontal passages, which are separated by pillars of ore. The pillars of ore are then gradually removed, keeping the work on the upper sub-drifts further advanced than on the lower and controlling the settlement of the overburden by a mat of timbers that is constantly being added to as the deposit is mined. This operation is known as stripping and as soon as it is completed down to a main level, the level is abandoned and all communication with the sub-drifts below must be through the lower level. The usual procedure is to sub-drift between this level and the next level below, so as to have these pillars ready for stripping as soon as operations are completed above. The advantage of this method of mining over the top-slicing system is, that large outputs are possible owing to the greater number of working places.

Various stoping systems are used in the Lake Superior region depending upon the character and the size of the ore body and the character of the ore. In general these systems are best adapted to comparatively narrow and rather steeply inclined deposits, but they are sometimes used in combination with caving systems.

Chapter V

CLASSIFICATION OF LAKE SUPERIOR ORES

In the early days of iron ore mining and up to within a comparatively few years the ore from any one mine was fairly uniform in composition. As the production increased, however, and the field of available ore was broadened to include deposits previously regarded as unprofitable, it became necessary to grade ores according to their composition, and further to mix ores of a different composition to produce certain grades. At present it is quite common for one mine to ship several different grades and for the ore from several mines to be grouped under one name. These conditions brought about a necessity for knowing the exact composition of the various ores, and whether or not, in the case of mixed ore, each cargo was of grade guaranteed.

The successful operation of a blast furnace depends largely on keeping the conditions under which it is running constant, The ore must be charged into the furnace with the proper proportions of limestone and coke, so that the impurities will flux properly and the desired grade of iron be produced. These proportions of fluxing materials and fuel vary with the composition of the ore. At the beginning of the year the furnace manager determines his requirements, as to limestone and coke for the coming season, using the analyses, as guaranteed by the sellers of the ores, which he expects to use. In this manner the cost of the pig iron is determined. If the composition of the ore varies from the guaranteed analyses, it is apparent that the furnace manager will be forced to make troublesome changes from his schedule. He will have to increase or decrease the amounts of coke or limestone in his charge, raise or lower the blast temperature, and finally he may not even be able to make the expected grade of pig iron. Thus, it can be understood readily that a thorough knowledge of all phases of the variability or regularity of ore composition is of paramount importance to the consumer as well as to the producer of iron ore.

The chemical reactions which take place within a blast furnace are complex, but the following is a brief description of the several steps in the reduction of iron ore: The oxygen of the air which is blown in at the tuyeres meets the glowing coke and forms carbonic acid gas (CO_2). This gas is at once reduced to carbon monoxide (CO) and is the active agent in the reduction of the ore. The ore, which is an oxide of iron, loses its oxygen to the carbon monoxide forming carbonic acid gas and metallic iron. The carbon acid is again reduced by the incan-

descent coke and the resulting carbon monoxide reduces more ore. These reactions continue until finally the carbonic acid is carried out of the top of the furnace together with some carbon monoxide and the nitrogen of the air. Unfortunately all of the impurities do not stay in the slag. Practically all the phosphorus, quite a considerable amount of the sulphur, about three-fourths of the manganese, and more or less silicon, reduced from the silica, go into the iron. All the alumina, lime and magnesia of the ore stay in the slag. Lime and magnesia to a certain extent are desirable constituents of iron ores, because in using such ores in a blast furnace, less limestone is required to form a slag. Alumina is not so desirable, the less sulphur the better, and the amount of phosphorus determines whether the ore is bessemer or nonbessemer. Manganese, within certain limits, is not harmful in an ore.

Strictly speaking, a bessemer ore is one in which the phosphorus is low enough to make bessemer iron, which latter is supposed to contain not over 0.100 per cent phosphorus. Hence theoretically, the maximum allowable phosphorus in a bessemer ore depends on the iron contents. A common way of expressing this is, that the numerical figures of the dry phosphorus percentage must not exceed the numerical figures of the dry iron percentage, that is, if the dry iron in an ore is 55 per cent, the phosphorus should not exceed 0.055 per cent. The phosphorus in a bessemer ore may vary widely, but it is generally accepted in the trade that the maximum must not be over 0.060 per cent. A nonbessemer ore is one whose phosphorus content is too high to make bessemer iron.

All iron ore contains a certain amount of moisture as it comes from the ground. As the ore is unloaded at the furnace, this moisture will be more or less than it was at the mine, depending on whether it has been subjected to wetting or drying conditions. Bebore the chemist determines the iron or any other constituent, the sample is dried at 100 degrees Cent., which is the same as 212 degrees Fahr. This drying, of course, removes all the moisture from the ore, except that which is chemically combined. This is done in order to have the sample in a uniform physical state. If the ore was not dried, two chemists working on the same sample probably would not be able to get the same results. For instance, in determining iron they would not have the same amount of ore in the weight taken by each, because of more or less moisture present.

The furnaceman, however, is not so much interested in the "dry" analysis, since, when the ore is weighed into the furnace, it contains more or less moisture. This is the reason why analyses are reported in both the "dry" and "natural" conditions. The "natural" represents the iron in the ore, in the condition in which

it is sampled, and the analysis is, of course, a calculated one. For instance, the "dry" analysis shows the iron to be 60 per cent, and the moisture 10 per cent; subtracting the percentage of moisture from 100 per cent, and multiplying the remainder by the "dry" iron, we have 54 per cent, which is the "natural" iron in the ore. The same method of procedure gives the natural analysis of the other constituents of the ore, and in calculating a burden for a blast furnace the "natural" analysis is used.

Sampling Lake Superior Iron Ores

In the early days of the iron ore industry, the question of sampling received but scant attention. Samples of ore were shown, and assurances given that shipments would be uniform and of a certain composition. Comparatively few ores were on the market; these were well known and were high in iron. As the demand for ore increased, more ore was produced, and it became necessary for the seller to guarantee the iron content, determined in the ore dried at 212 degrees Fahr. At times it was found somewhat difficult to keep the ore up to this guarantee, and it became a custom to divide the selling price by the guarantee, thus establishing a unit value. Averaging the analyses made by the buyer and seller and multiplying by the unit value, gave the selling price of the ore.

After the soft ores came onto the market, the question of moisture became of great importance and a readjustment of the guarantee became necessary, changing the basis from the dry to natural conditions. For many years the value of ores was arrived at by adding an average freight rate to the valley furnaces to the price quoted at lower lake ports, and dividing this sum by the guaranteed percentage of natural iron. This gave a base unit value which multiplied by the percentage of natural iron, gave the selling price of the ore. In 1908 a new method of figuring the value of an ore was adopted by most of the sellers. This method is described elsewhere in this book.

Probably nothing in connection with the handling of iron ore has been the subject of more disputes than the question of sampling. Much has been written about the matter, and it has been clearly demonstrated that the subject is an extremely complicated one, and one in which higher mathematics play an important part. The sampling of the ore, however, must necessarily be done by a class of men not familiar with higher mathematics, and, as a rule, not capable at all times of exercising proper judgment as to the correct proportions of lump and fine, wet and dry ore.

Since the calculation of a blast furnace burden is dependent on the analysis of the material to be used in the furnace, it is of great importance that the sample of ore be as near correct as possible. Analytical work has been standardized until at present the various constituents of iron ore can be determined accurately, at least within very narrow limits of error. If the sample is not

taken correctly, the chemical analysis, however accurate it may be, is of no practical value. It is necessary and of greatest importance, therefore, that methods of sampling should be so standardized that a truly representative sample may be taken in every case. This has been done at the lower lake ports, is being agitated at the furnaces, and is being brought about at the mines. We do a large amount of this work, and have given the matter very careful consideration. It is our opinion that the judgment of the sampler should be depended upon as little as possible; in other words, the nearer we can approach a mechanical sample, the more liable we are to obtain a correct average of the ore.

*"It is believed that the conscientious use of the standard methods of sampling as presented for the various conditions of mining and transportation, together with a close adherence to the details of the methods of analysis as indicated, will serve to continually lessen and eventually remove discrepancies which may exist between producer and consumer."

On account of the varying conditions at the different mines and furnaces it probably is impossible to determine upon any one method of sampling which would apply at all times and in all cases. However, it would seem as though some general principles might be suggested which would tend to overcome the difficulty of getting a representative sample of ore. Many mine operators have appreciated the importance of this factor in the iron ore trade, and have adopted standardized methods of sampling.

**Sampling in General

"Iron ores are divided into two classes, soft and hard. A soft ore is described as one which contains in place all fine or all hard material, or both, but after displacement it is disintegrated into a fine texture frequently containing a considerable amount of lumpy material, the percentage of which, however, is less than the fine. A hard ore is a firm compact mass in place, which breaks into hard lumps when blasted in mining.

"It is the purpose of the following methods that they be general in their scope, advocating the principles applicable to ore sampling in general without attempting to prescribe for varying and unforeseen contingencies. The nullifying effect of improper sampling upon subsequent analyses is self-evident, and it is essential that the sampler be given every possible aid by those in charge of mines and in charge of unloading devices.

Sampling at Mines

"Iron ore in the Lake Superior region is mined by open-pit, underground and milling methods. Prospecting is done

*From Preface Second Edition Methods for Commercial Sampling and Analysis of Iron Ore, United States Steel Corp.

**Methods for the Commercial Sampling and Analysis of Ore, United States Steel Corp.

by drilling. Wherever possible the ore is churn drilled. Where the ore is too hard for churn drilling, diamond drilling is used. Samples are taken from material representing each 5 feet of drilling, or less, if there is a change in the character of the ore. Samples from churn and diamond drillings should never be taken together; that is, if churn and diamond drilling has been resorted to in the same 5 feet or less, a sample should be taken of each.

Churn Drill Samples

"In the process of churn drilling, water, pumped to the bottom of the hole through the drill rod and returning between the rod and the casing pipe, carries the cuttings with it. It is necessary to keep the casing as near the bottom of the hole as possible to prevent material above from falling down and mixing with that being drilled.

"All material carried up while drilling the 5 feet or less is caught in barrels, each of which is provided with a stoppered hole 10 inches from the bottom. Four barrels are usually provided to receive this water, but more may be required if the ore is of a very light nature, and does not settle readily. These barrels are successively filled, allowed to settle and drained to the hole, until the desired depth is drilled. The 10 inches of sediment left in the barrels is transferred to a settling tub or barrel, and care is taken that all material is removed. In the final tub or barrel the complete sample is allowed to settle as long as is practicable, but never less than two hours. The water is then drawn off in the usual manner through the hole, and the remaining material constitutes the sample. Care must be taken in draining the water from the samples, as any shaking or rough handling will cause the loss of light material which should be retained as a part of the sample. This ore and water sample is carried to the sample house, where the water is evaported over steam pipes, until the sample is dried sufficiently to mix well. It is then mixed, crushed and prepared for analysis in the usual manner.

Diamond Drill Samples

"In the process of diamond drilling, cores of the material drilled are usually obtained. A sample is taken from each 5 feet or less of ore material drilled by dividing the core obtained, longitudinally, into two equal parts. One half constitutes the sample, while the other half is retained to show the physical structure of the formation.

"Occasionally, however, the core is ground to powder and is carried to the surface with the diamond drill cuttings by the return water. In this case the method of obtaining the sample is identical to the method described under churn

drilling. At other times core and powder are obtained in the same 5 feet. In such case the powder and cuttings are recovered as in churn drilling; this material together with all the core obtained constitutes the sample. If desired, however, the fine material collected in barrels and the core may be analyzed separately. Sluice boxes are sometimes used in place of barrels.

Test Pit

"A test pit is a hole about 3 feet square and of any desired depth, made for the purpose of exploring the underlying ore. Samples are taken to represent each 5 feet of depth where the ore is uniform; where rock or lean ore occurs in the same 5 feet, representative samples are taken of each material. If the ore lies in horizontal strata, opposite or adjacent walls are sampled, while if the strata is not clearly defined, the four walls are sampled. The walls to be sampled are first cleaned. A vertical groove, 3 inches wide and 2 inches deep, is then cut down the middle of the wall from top to bottom of each 5 feet length. The material thus removed is caught in a pan or box and the two or four cuts, as the case may be, combined.

"If desired, all material removed in digging the test pit may be quartered down until a small sample is obtained or the entire bottom of the pit is sampled after each drop of 5 feet.

Underground Sampling: Drift and Crosscut

"Starting from some permanently fixed point at the entrance, the drift is divided into sections 25 feet in length. Each section is sampled at four stations. Stations 1 and 3 are on one side of the drift, and immediately opposite are stations 2 and 4. The relative position of the stations is maintained in each succeeding section. The sample representing each section is obtained by cutting a groove at each station, 3 inches wide and 2 inches deep, across the entire face of the ore at right angles to the formation. Length of sections may be decreased and the number of stations in each increased if the character of the ore formation is such that closer sampling is desirable. In this case it is often the practice to continue the groove over the back of the drift and down the opposite side, at regular intervals, in each section. If any section shows part rock and part ore, or two entirely different grades of ore, they are carefully measured and sampled separately.

"A crosscut is a branch drift running at right angles to the main drift. It is sampled in the same manner as a drift.

Stockpile Sampling

"Stockpiles are generally accumulated at shaft mines when the shipping season is closed. They have in general

the following dimensions: Base, 50 to 100 feet wide; top, 30 to 80 feet wide; height, 20 to 30 feet; length, 50 to 500 feet, depending upon circumstances.

Daily Sampling During Stocking

"The new face of the stockpile is divided into 2 to 10-foot spaces or stations by vertical lines, and portions are taken over the face of each station and along the vertical lines at 2 to 10-foot intervals. Such samples are taken every one and half to two hours, and two or more rounds may constitute a sample.

Completed Stockpile

"Soft Ore: The stockpile is divided by imaginary cross section lines from 2 to 10 feet apart. Starting at one end, 2 feet from the base, samples are taken along each line from 2 to 10-foot intervals over the entire pile as shown. Each line represents a sample if so desired. The ends are sampled in like manner, starting 2 feet from the base and ending at the top. If for any reason it is necessary to sample the stockpile more thoroughly this may be accomplished by test pit sampling, gopher holes or drift sampling, or the pile may be cut by trenches from top to bottom at various points, and exposed faces then sampled.

"Hard Ore: In sampling hard ore stockpiles, the knotted rope system, with knots 2 to 10 feet apart, is used. Beginning at one end, the rope is stretched over the stockpile and a small portion about 1 cubic inch in size is chipped from the material that lies directly under each knot. The rope is then moved forward from 2 to 10 feet, and the operation repeated until the entire pile is sampled. Each line may be worked up separately or the various lines may be combined as desired.

During Shipping

"Samples are often taken ahead of the steam shovel in order to get the analysis of the ore before it is loaded. In this case the piles are measured and stakes are driven every 50 feet along the side. Each section of 50 feet is then divided into stations 5 feet apart, and successive portions are taken every 5 feet up the pile to a point where, in the sampler's judgment, the cut will end. This process is continued at each station until the entire 50 feet are sampled.

"If desired, trenches are dug up the side of the pile at every 25-foot interval. These trenches are about 6 inches wide and 1 foot deep. All material so excavated constitutes the sample.

Railroad Car: Soft Ore

"Cars are sampled, using a suitable implement, as soon as possible after they are loaded.

"The parallel system is followed. The first line is located in the middle and lengthwise of the car. The other two lines are about two-thirds the distance from this line to the sides of the car. The points of sampling are arranged symmetrically on these lines and with a minimum number of 24.

"As a rule, 10 cars is the maximum number combined into one sample, but fewer than this number may be combined. The weight of the sample is not less than 20 pounds.

Railroad Car: Hard Ore

"When hard ore is sampled the rope net system is used, which gives about 32 points on each car, since the knots are 18 inches apart. In using the net system, if a lump of material comes directly under a knot, a piece is taken about the size of 1 cubic inch. If fine ore occurs under a knot, an equal amount is taken."

STANDARD METHOD FOR SAMPLING CARGOES OF IRON ORE AT LOWER LAKE PORTS

In 1907 the Cleveland chemists adopted a standard method of sampling which has been improved from year to year, and has shown itself capable of giving accurate results if conscientiously carried out.

The following method of sampling is used by the independent chemists of Cleveland at the lower lake ports:

A standard sample shall be taken from all cargoes, the weight of the sample varying with the size of the cargo. The sample shall be taken with an iron scoop, 3¼ inches long, 2½ inches wide and 1½ inches deep, the handle 8 inches long, and with a hammer 12 inches long the (scoop holds approximately ½ pound). It shall be the aim to take an equal bulk of ore from every point selected. When a lump is encountered a portion shall be broken off equal to a scoopful of soft ore. In sampling cargoes, no sample shall be taken from the original outside surface on account of the presence of foreign matter and an undue proportion of fines.

If the surface to be sampled has been exposed to rain or sun long enough to materially alter the amount of moisture present, the sample shall be taken about 3 inches below the surface.

In order to keep the size of samples within reasonable bounds and to gauge the size to the size of the boat, the sampler shall on cargoes up to 2,500 tons, begin sampling at a convenient point, at the bottom of the face of the ore and shall take one standard

scoopful every two scoop lengths up the face of the ore to the top, and then shall move four scoop lengths to one side of the starting point before again sampling vertically. He shall continue in this manner keeping the above distances around the face of the ore to the place of beginning.

On cargoes from 2,500 to 6,000 tons, he shall use the two scoop lengths for vertical distances up the face of the ore, but move six scoop lengths horizontally.

On cargoes over 6,000 tons, he shall use the two scoop lengths for vertical distances up the face of the ore, but move eight scoop lengths horizontally.

In cases of split cargoes, horizontal spacing to be according to the tonnage of each individual ore as specified in the preceding paragraphs.

At convenient stages of unloading, the sample shall be mixed and quartered. This must be done each time exactly alike, by breaking down to ½-inch, mixing and quartering twice, thus preserving the proper proportion of the whole sample.

If in the final quartering, the last two quarters exceed a can full, the ore shall be quartered again and one-quarter rejected.

The sample may be quartered on the vessel, or may be taken to some other place suitable for the purpose. Samples must be shipped in standard cans.

Sampling Soft Ore

The sampler shall enter any hatch and begin sampling when the unloading machines have exposed 5 or 6 feet of the face.

The sampler shall then enter the next hatch working, and proceed to sample in the same way, and so continue in every working hatch.

The sampler shall begin over again in the hatch in which he first started and continue the sampling in all the working hatches, provided there has been sufficient ore removed in such hatches since the faces were sampled to expose fresh ore.

The sampler shall continue this method of sampling until there is less than one-tenth of the ore left.

In sampling horizontal surfaces, as in boats where scrapers are used, the sampler shall sample every two scoop lengths lengthwise of the boat, the spaces between the lines of sampling to be four, six and eight scoop lengths according to the tonnage as described before.

Sampling Hard Ore

In sampling hard lump ore the sampler shall begin sampling and use the same spacing as defined for soft ore, using hammer lengths, instead of scoop lengths. At each point sampled he shall take lump or fine ore equal to 1 cubic inch. In taking this cubic inch the sampler shall take an average from the lump ore from which the cubic inch is broken.

Moisture Sample

The moisture sample shall be taken from the standard sample in the following manner:

When as many cans of ore have been filled as the stage of unloading will permit, the lump ore shall be broken up quickly, and the entire amount thoroughly mixed and flattened out into a circular pile. The pile shall then be marked into quarters and one of the quarters divided into two parts by a radial line from the center to the outside of the pile. The whole of one of the half quarters so marked off is to be placed at once in a tightly covered receptacle to be a portion of the moisture sample. The other half of the quarter, together with the opposite quarter, are to be rejected.

The remainder of the pile is to be thoroughly mixed and flattened and two opposite quarters rejected. The remainder of the ore is to be put one side for a portion of the standard sample.

By this method of procedure, one-eighth of the entire sample taken will go into the moisture sample.

At the end of the sampling the accumulated moisture sample is to be taken out of the tightly covered receptacle, quickly mixed and flattened out, divided into eighths and enough eighths taken to fill the standard moisture can.

In case of hard ores or small tonnages of soft ore, the proportion set aside for the moisture sample shall be increased so that at least one can of ore shall remain for the final moisture sample.

The moisture determination is made by drying the whole of the final moisture sample at a temperature not over 212 degrees Fahr. until there is no loss in weight. The loss of weight divided by the amount of ore taken, will give the percentage of moisture.

SUGGESTED METHODS OF SAMPLING AT THE MINES AND FURNACES

Mine Sampling

The sample should be taken from railroad cars after the cars are loaded, as follows: Begin at one end of a car in the center, measure two hammer lengths along center line parallel to sides. At this point take a scoopful, if fine ore, or an equal bulk if lump ore. Measure the same distances and take same quantities in the same way until the other end of car is reached. Then repeat the operation on a line one-half way from center line and side, and then repeat again on line one-half way from center line and other side. For ordinary ores have hammer of such lengths that this proceeding will take ore from five points in each line, or 15 points per car. For variable ores shorten the length of the

hammer so as to touch eight or ten points in each line, giving 24 or 30 points to each car.

These car samples may be analyzed separately, or bunched in groups of five or ten for analysis. Using these car samples as units, the cargo analysis can then be calculated from the cars going into the cargo.

Sampling Cars at Furnace Plant

Ore as received at the furnace plants in cars, has been loaded by grab bucket in nearly all cases. This method of loading itself tends to mix the ore so that a proper sample from the surface is fairly representative of the whole car.

Starting at a point 1 foot from the end of the car, move in a straight line lengthwise through the middle of the car over the piles of ore, taking equal bulks of ore every 3 feet. Measure these distances, and at the designated point dig about 4 inches below the surface and take a measured bulk of either lump or fine, whichever is encountered. A scoop holding about 0.5 pound of ore could be used, with a handle about 12 inches long, and the scoop may be used for measuring the distances; or, a measuring stick of the right length could be used, without inconvenience to the sampler. This method of sampling could be elaborated, if thought necessary, by going across the car twice more on lines about two-thirds the distance from the center of the car to the side of the car. This, of course, touches the ore in three times as many places, and in the case of mixed ores would tend to give a more representative sample.

The Steel Corporation Sampling Committee recommends the following as a suitable method for sampling cars at the blast furnaces:

> "When cars are loaded with fine ore with the piles in opposite ends, at least five samples are taken from each pile with a Markley ore pick, the first one at the apex of the pile, and the other four at points symmetrically arranged around the sides of the pile, two-thirds of the distance from the apex to the base of the pile or the sides of the car."
>
> "With cars loaded in the center, the system is the same, except that the 10 points are located by first finding the center of each side of the pile lengthwise of the car, and arranging four other points symmetrically around each of these points."
>
> "When the 10 points are located in a car, each of them is supposed to represent a definite area equal to one-tenth of the ore surface of the car. If the car contains all fine ore, then 10 equal size samples are taken, one from each of the points. If the car contains a mixture of fine and lump ore, with varying amounts of each in the areas included

in the different divisions, then each area is judged separately and sampled accordingly. The fine and the lump ore are taken each in their proper proportions, the former with the sampling pick, the latter being chipped with the hammer, or small pieces may be selected from the fine ore. The combined sample, of fine, chipped or selected pieces, from each area should equal the amount taken were it all fine ore. If the contents of the car are all lump ore, the proper sized pieces are chipped from four or five of the lumps in each of the 10 areas, making 40 or 50 pieces from each car, and the total amount of chipped pieces from each of the areas should equal the amount that would be taken were it all fine ore. All samples of fine ore are taken from well underneath the surface to obtain the ore in its natural state. A proportionate amount of the main sample may be retained in a tightly closed can for the moisture determination."

The method used for sampling by the Cleveland-Cliffs Iron Co., at their mines is described by Mr. R. W. Bowers, chief sampler, as follows:

"The methods of sampling iron ore at the mines of the Cleveland-Cliffs Iron Co., consist either in a tops-of-cars sample, a dipper sample, or a skip sample. The procedure in sampling by any of these methods may be described as follows:

Tops-of-Cars Sample

"This is taken by the use of a rope, preferably a clothes-line, knotted each 18 inches of its length, and a hammer and a scoop. The standard scoop measures 3½ x 2¼ x 1¼ inches deep, and holds about one-half pound of ore. The rope, as applied to the usual railroad cars at the mine, is knotted at 15 intervals of its length and is placed diagonally over the car from end to end, and a scoopful of sample taken at each spacing. This amounts to about 8 pounds of sample to a car.

Dipper Sample

"This consists of a standard scoopful of ore from one or more places from each dipper of ore loaded by the steam shovel at the stockpile. Ordinarily this sample is taken at random, the sampler determining by the appearance of each dipper of ore, the proper amounts of lump and fines to be included in the sample. On difficult ores, the lump and fines of which differ in any particular, the sample may be taken by the use of a rope, knotted at one or more places, which, when thrown over the ore, determines exactly the proportions of lump and fines taken as the sample.

Skip Sample

"This is taken at the pocket, from each skip loaded into the railroad car, either by the use of a scoop or a dipper. When taken with a scoop, each skip is sampled from the railroad car, from one or more places, either by use of a rope or not, as the nature of the ore may require. When taken with a dipper the sample is caught at the lip of the pocket chute, from the running ore, one dipper full from each skip dumped.

"Samples from all of the mines are accumulated in units of from one to twenty cars, depending upon from how small a unit of loading the analysis is required. Pocket samples are usually accumulated for all cars loaded for a shift or for a day, with the exception of bessemer ores for which it is sometimes found necessary to sample and analyze each car as a unit. On stockpile loading the sampling is done in 5, 10, 15 or 20-car units, and occasionally on separate cars, depending upon the character of the ore. The usual unit of loading for which sample is taken and analysis made consists of 15-car lots of nonbessemer ores, and of 5 or 10-car lots of bessemer ores. In general the dipper sample is taken in place of the tops-of-cars sample, if the unit of loading consists of less than 10 cars to the lot. By dividing the day's samples into several lots, rather than one large sample representing the entire day's loading, the samples are kept down to a size convenient for handling, and the effect of any error, in taking the samples or in their subsequent handling, is confined to a smaller amount of ore loaded."

Chapter VI.

BENEFICIATION OF LAKE SUPERIOR ORES

Shipments of iron ore from the Lake Superior district up to and including 1919 reached the total of 946,545,917 tons. The state tax commission of Minnesota estimated the reserves of iron ore in Minnesota in 1919 at 1,394,923,451, apportioned among the ranges as follows: Mesabi, 1,325,035,574; Vermilion, 11,059,237; Cuyuna, 58,828,640. The first assessments equalized by the Minnesota tax commission, in 1907, were on a basis of 1,191,969,757 tons of merchantable iron ore in the ground. The assessed valuation was $191,706,682. Since that year approximately 420,000,000 tons of iron ore have been shipped from Minnesota, but despite this, according to the tax commission's records, the 1919 record of merchantable iron ore in the ground was 202,953,694 tons greater than in 1907, and the assessed valuation was $97,233,693 greater, due to new developments. In addition to the commission's estimate of merchantable tonnages it was stated in 1919 that there were approximately 175,000,000 tons of iron ore of record in the tax commission's office, the grade and character of which were such that market conditions and standards made it nonmerchantable, but which at some future time may have a market value.

Only seven mines in the Lake Superior district shipped more than 1,000,000 tons of ore in 1919, while this output was exceeded by more than 12 mines in 1918. Those which shipped more than 1,000,000 tons in 1919 were: The Canisteo, which shipped 1,255,668 tons; Hartley-Burt-Palmer, 1,064,838 tons; Hull-Rust, 5,100,555 tons; Kerr, 1,693,389 tons; Missabe Mountain, 1,260,095 tons, and the Mahoning, 1,237,168 tons, all of the Mesabi range; and the Norrie group on the Gogebic range, which shipped 1,335,468 tons.

Records of shipments have a bearing on the subject of beneficiation of ores as showing the immense tonnages that are being removed from the Lake Superior district in proportion to the estimated reserves. In another chapter in this book the average analyses of the iron ores since 1902 are presented, showing the variation in the quality of the ores, and it is interesting to note in this connection that if the average content of iron holds up in the next ten years as well as it has since 1902, the average percentage of iron of all grades of iron ore in 1930 will be about 51 per cent, which is not appreciably lower than the present average. But while the average quality of the ore has been well sustained by means of careful mixing and analysis, the time is not far distant when the percentage of high-grade ore will begin to show more of a decline; that is, there will be less tonnage of

the better grade of ore for mixing with the leaner ores, and this must inevitably show in the record of analyses.

It is with this contingency in mind that some of the largest producing companies are devoting attention to the beneficiation of ores. As a general proposition, buyers of Lake Superior ores demand a product of the highest quality available and comparatively few ores of inferior grade have been shipped. If the leaner ores are smelted in their natural condition, the cost of producing pig iron will increase, due not only to the fact that additional ore, coke and limestone will be required to produce a unit amount of pig iron, but also to increased operating and overhead charges at the furnaces. These factors are compensated for, to some extent by the lower price of ores of inferior grade, but it is probable that the solution of the problem lies in the concentration of the lower grade of ore and the production of a high-grade shipping product.

At present concentration is being adopted in a number of instances in the Lake Superior region, but it is probable that the present policy of taking the best of ores available will be adhered to until operators are forced by necessity to resort to the lower grade ores. Recent estimates of the iron ore resources of the Lake Superior region show that the ores that are now of commercial grade will be exhausted in a comparatively few years and that the great bulk of the iron ore resources of the region will average less than 45 per cent in iron. Concentration methods that will make this low-grade ore available are sure to become of increasing importance.

At present there are three methods of beneficiating ores as found on the Mesabi range. Certain ore deposits comprise an ore which is merchantable, but which contains a large percentage of fine sand and not infrequently a deleterious percentage of paint rock, rendering it unmerchantable as mined. The fine sand and paint rock are capable of being removed by simple washing. The machine used for this washing process is a log washer which does not differ in principle from the old Thomas log washer used for years for washing ores in Pennsylvania and certain localities in the South. Mesabi range practice has, however, greatly improved the mechanical construction of this machine in order to reduce maintenance and increase tonnage.

Certain other deposits consist of ore plus a variable percentage of rock. The ore is merchantable but the presence of the rock renders it unmerchantable, unless the rock be removed. Ordinarily the rock is of such size that screening with ordinary stationary grizzly bars answers the purpose, although an improved form of screening machine or grizzly, the chain grizzly, has been evolved in the past few years. A third type of ore deposit comprises a material which is all merchantable but which

contains in addition to the reasonably fine ore, chunks of ore too large to be shipped to the furnace. To make such a deposit merchantable it is necessary that the chunks be crushed to merchantable size and this involves the removal of the fines and then the crushing of the chunks.

Recently the Oliver Iron Mining Co. erected two large plants, one at Eveleth, Minn., and other at the Morris mine, Hibbing. Other companies also have been active, and it is now estimated that there are on the Mesabi range approximately 12 washing and screening plants.

The ore tributary to the Oliver's plant at Eveleth is both wash ore and crush ore and consequently the plant really comprises two plants, the washing side and the crushing side. The washing side comprises a chain grizzly for screening out the oversize which is too large to be fed to the washer. If the oversize of the chain grizzly consists of ore in fairly large chunks this ore passes to a No. 8 gyratory crusher and then to the shipping bin. If, however, the oversize of the chain grizzly is low grade rock it is delivered to a rock bin and then conveyed to the rock dump. The throughs from the chain grizzly are conveyed by a belt conveyor to a revolving trommel with 2-inch holes and the throughs from the tunnel pass to a log washer. This log washer differs from the log washers in use at the other washing plants in that it is 35 feet long. In all the other washing plants on the range, the overflow or tails from the log washers pass to settling tanks and then to 18-inch log washers, locally known as "turbos." By increasing the length of the logs from 25 to 35 feet and giving the logs a wide and slow overflow the material which in other plants receives a secondary washing in the "turbos" is retained within the logs, thus dispensing with the second washing of the fines.

The other side of the Eveleth plant is designed to handle such ores as contains large chunks, all sufficiently high grade to warrant crushing. It comprises a chain grizzly and a jaw crusher, 48 x 60-inch opening. The throughs from the chain grizzly are conveyed by a belt to the shipping bin. The chain grizzly acts also as a conveyor so that its oversize is fed directly to the crusher. The crushed ore is fed on to the same belt that conveys the throughs from the grizzly to the shipping bin.

In the Morris pit there are deposits of ore which contain low-grade rock. This pit also contains deposits of ore much of which is in the form of large chunks. The Morris plant, therefore, is practically two plants, one for crushing, and the other for screening. The crushing plant comprises a chain grizzly, the throughs from which are discharged to a belt conveyor and conveyed to the shipping bin. The oversize, consisting of large chunks of merchantable ore are conveyed by the chain grizzly to the 48 x 60-

inch jaw crusher, and the product of this crusher feeds on to the same belt and delivers in the same shipping bin.

Wet concentration methods also are now in use at the Trout Lake plant of the Oliver Iron Mining Co., near Coleraine, at the Hawkins, Quinn-Harrison, Crosby, York and La Rue mines in the Nashwauk district, and at the Madrid mine at Virginia, on the Cuyuna range, at the Rowe mine and on the Marquette range at the American mine, near Diorite.

The Trout Lake plant is located in what is known as the Coleraine district on the west end of the Mesabi range and receives ore from a number of mines operated by the Oliver Iron Mining Co. The ore is received at the mill in railroad cars operated over an enormous earth fill which is approximately 4,000 feet long, terminating in a steel trestle, 650 feet long and having an elevation of 90 feet above the railroad tracks that are below the shipping bins. The ore is dumped from the cars into receiving bins and is handled in the mill entirely by gravity. The mill consists of five units, each unit being capable of independent operation. Each unit consists of a receiving bin having a capacity of 450 to 500 tons, from which the ore is sluiced by water jets over a bar grizzly into a revolving conical screen with 2-inch openings. The oversize from the screen is delivered to the shipping bin by a picking belt, and the undersize is treated in two 25-foot log washers. The concentrates from the log washer are discharged directly into the shipping bin and the tailings are de-watered and treated in two 18-foot "turbos" or small log-washers. The concentrates from the turbos are discharged directly into the shipping bin and the tailings are de-watered and treated on 20 Overstrom tables. The concentrates from the tables are elevated by Frenier pumps to de-watering tanks and discharged directly into the shipping bin. The tailings from the mill are collected by launders in the mill basement and are discharged into Trout Lake by a concrete launder that is approximately 2,000 feet long. The plant was completed in 1910, and its capacity is approximately 3,000,000 tons of crude ore per season.

The plants in the Nashwauk district, with the exception of that at the La Rue mine, embody the same principles as the Trout Lake plant; the distinctive features being in the methods of handling the crude ore which is received in bins located outside of the plants and is elevated to the tops of the mills by means of troughed belt conveyors, which discharge directly onto grizzlies doing away with receiving bins at the tops of the mills. The Hawkins plant was completed in 1912, the Quinn-Harrison in 1914, and the Crosby plant in 1916.

The plant at the La Rue mine differs from the other plants on the Mesabi range, in that the turbos and tables in the ordinary plant are replaced by Wetherbee concentrators.

One of the most interesting of the new plans proposed for the concentration of ores, from the standpoint of commercial possibilities for utilizing immense tonnages of low-grade ores, is that pertaining to magnetic separation of the ores as found on the eastern portion of the Mesabi range.

The deposits of the east end of the Mesabi range cover very large areas, and consist of the same taconite that produces the hematite of the central and western Mesabi. It is not deeply covered with drift, but outcrops boldly in large masses. It is not concentrated locally into enriched bodies separated by leaner areas, but is all a fairly uniform, hard, banded, unaltered chert, carrying about 25 to 30 per cent iron as magnetite.

The Mesabi Iron Co., organized by Hayden, Stone & Co., and under the direction of D. C. Jackling, has taken over these deposits and is building a concentrating plant at the new town of Babbitt about 14 miles east of Mesaba, Minn. This plant is to have a capacity of 2000 to 3000 tons per day and is based on the application to this low-grade material of the methods which have made the so-called Porphyry copper properties so successful.

In 1916 an experimental mill was built in Duluth containing full sized machinery and capable of handling from 100 to 200 tons daily. A considerable tonnage of material was concentrated during 1916, 1917 and 1918. The work showed that the resulting product could be varied, almost at will, between 60 per cent and 70 per cent iron and .006 per cent to .030 per cent phosphorus, and that this could be made on a large scale well within the limits of cost set by iron trade conditions. A small special cargo was sent down the lakes late in 1918 assaying 63.27 per cent iron (natural and dry) and .008 per cent phosphorus, but it is assumed that large-scale shipments will normally be of a bessemer product carrying about 63 per cent iron and .020 per cent to .030 per cent phosphorus. This material is a sinter, carrying only traces of sulphur and titanium, with silica between 6 per cent and 10 per cent and alumina, lime, magnesia and manganese, each below 1 per cent. Some of the iron in this sinter is hematite and some is magnetite, the percentages varying according to the treatment given on the sintering machine. Like the analyses, this hematite percentage is within reasonable control. Sinter made from finely ground magnetite has much the structure of coke, being firm yet porous, and gives good account of itself in the blast furnace. The methods to be used in the plant now under construction are about as follows:

1—Stripping: Very light. Much of the deposit has no covering at all.

2—Quarrying: Side hill work. Faces 40 to 60 feet high. Churn drill holes and heavy blasting.

3—Steam Shovel.

Railway	Location	Dock No.	No. of pockets	Capacity per pocket cars.	Storage capacity.
Chicago & Northwestern Ry	Escanaba, Mich.	3	226	2 @ 50 tons 1 @ 25 tons	28,25
Chicago & Northwestern Ry	Escanaba, Mich.	4	250	2 @ 50 tons 1 @ 25 tons	31,25
Chicago & Northwestern Ry	Escanaba, Mich.	5	370	5 @ 50 tons	92,50
Chicago & Northwestern Ry	Escanaba, Mich.	6	320	5 @ 50 tons	80,00
Chicago & Northwestern Ry	Ashland, Wis.	1	290	5 @ 50 tons	72,50
Chicago & Northwestern Ry	Ashland, Wis.	2	278	4 @ 50 tons	55,60
Chicago & Northwestern Ry	Ashland, Wis.	3	200	5 @ 50 tons	50,00
	Total		1,934		410,10
Duluth & Iron Range Railroad	Two Harbors, Minn.	1	224	5 @ 50 tons	56,00
Duluth & Iron Range Railroad	Two Harbors, Minn.	2	228	6 @ 50 tons	68,40
Duluth & Iron Range Railroad	Two Harbors, Minn.	5	168	3 @ 50 tons	25,20
Duluth & Iron Range Railroad	Two Harbors, Minn.	6	148	5 @ 50 tons	37,00
	Total		768		186,60
Duluth Missabe & Northern Ry	Duluth, Minn.	3	384	3 @ 50 tons	57,60
Duluth Missabe & Northern Ry	Duluth, Minn.	4	384	4 @ 50 tons	76,80
Duluth Missabe & Northern Ry	Duluth, Minn.	5	384	6 @ 50 tons	115,20
Duluth Missabe & Northern Ry	Duluth, Minn.	6	384	8 @ 50 tons	153,60
	Total		1,536		403,20
Great Northern Ry	Superior, Wis.	1	374	6 @ 50 tons	112,20
Great Northern Ry	Superior, Wis.	2	350	6 @ 50 tons	105,00
Great Northern Ry	Superior, Wis.	3	160	6 @ 50 tons	97,80
Great Northern Ry	Superior, Wis.	3	166	6 @ 50 tons	
Great Northern Ry	Superior, Wis.	4	302	6 @ 50 tons	90,60
	Total		1,352		405,60
Northern Pacific Ry	Superior, Wis.	1	102	7 @ 50 tons	35,70
		Extsn. of No. 1	100	7 @ 50 tons	35,00
	Total		202		70,70
Duluth South Shore & Atlantic Ry	Marquette, Mich.	5	200	4 @ 50 tons 1 @ 25 tons	45,00
Lake Superior & Ishpeming Ry	Marquette, Mich.	2	200	5 @ 50 tons	50,00
Minneapolis, St. Paul & Sault Ste. Marie Ry.	Ashland, Wis.	2	150	7 @ 50 tons	52,50
Minneapolis, St. Paul & Sault Ste. Marie Ry.	Superior, Wis.	1	402	6 @ 50 tons	120,60
	Total		552		173,10
Chicago, Milwaukee, & St. Paul Ry	Escanaba, Mich.	1	240	3 @ 50 tons 1 @ 25 tons	42,00
Chicago, Milwaukee, & St. Paul Ry	Escanaba, Mich.	2	240	4 @ 50 tons	48,00
	Total		480		90,00
Algoma Central & Hudson Bay Ry	Michipicoten, Ont.	1	12		
Canadian National Rys	Key Harbor, Ont.	1	20	2 @ 50 tons	2,00

:S ON THE GREAT LAKES

Revised to May 1st, 1920

Height water to center hinge hole.	Height water to deck of dock.	Width of dock outside to outside of part'n posts.	Length of spouts.	Length of dock.	Angle of pockets.	Cu. ft. per pocket to bottom of stringers.	Duluth & Iron Range Railroad W. A. Clark, Chief Engineer.
1' 2"	52' 8"	37' 0"	27' 0"	1,356'	45° 0"	1,969	
		37' 0"	30' 0"	1,500'	45° 0"	2,191	
6' 6"	59' 2"	52' 2"	32' 1½"	2,200'	45° 0'	4,142	
7' 9⅝"	70' 9"	50' 2"	30' 0"	1,920'	45° 0'	4,114	
0' 0"	70' 0"						
			30' 0"				
9' 0¼"	72' 1"	50' 2"	32' 1½"	1,740'	45° 0'	4,100	234 spouts 30' 0" long 56 spouts 32' 1½" long
9' 2½"	70' 4½"		30' 0"				
10' 4¼"	73' 5¼"	50' 2"	32' 1½"	1,668'	45° 0'	3,550	234 spouts 30' 0" long 44 spouts 32' 1½" long
		52' 2"	35' 4½"	1,200'	45° 0'	4,030	
9' 3"	74' 0"	51' 8"	34' 0"	1,376'	48° 0'	4,075	Steel and concrete
0' 3⅛"	80' 0"	56' 8"	35' 0"	1,400'	48° 0'	5,360	Steel and concrete
9' 0"	66' 9"	49' 0"	30' 0"	1,050'	43° 32'	3,126	
0' 0"	73' 0"	51' 3¼"	34' 0"	920'	45° 0'	4,220	Steel and concrete
10' 7"	67' 0½"	59' 0"	27' 9"	2,304'	45° 0'	2,782	Not in use.
11' 9½"	72' 6"	57' 0"	30' 1½"	2,304'	45° 0'	3,867	
0' 8"	80' 5"	56' 0"	36' 0"	2,304'	47° 30'	5,313	Steel and concrete
10' 4⅛"	84' 5"	60' 0"	36' 0"	2,304'	47° 30'	6,560	Steel and concrete
0' 0"	73' 0"	62' 8"	32' 4"	2,244	45° 0'	4,972	
0' 0"	73' 0"	62' 8"	32' 4"	2,100'	45° 0'	4,972	
8' 9"	77' 0"	59' 8"	34' 0"	960'	47° 30'	4,972	
0' 0"	73' 0"	62' 8"	32' 4"	996'	45° 0'	4,972	
0' 2"	75' 0"	62' 6"	34' 6"	1,812'	47° 30'	5,347	Steel and concrete
0' 6"	80' 0"	57' 2"	34' 0"	684'	47° 30'	5,490	Steel and concrete
9' 9"	80' 0"	59' 2"	34' ⅛"	600'	47° 30'	5,600	Reinforced concrete
0' 0"	70' 10"	51' 0"	32' 4"	1,236'	45° 0'	3,848	
3' 0"	75' 0"	54' 0"	35' 0"	1,200'	45° 0'	4,590	Steel and concrete
2' 0"	80' 0"	59' 0"	34' 6"	900'	47° 30'	5,100	Reinforced concrete
2' 5⅝"	78' 0"	58' 0"	32' 1½"	2,412'	47° 0'	4,775	
			120 @ 27'				
0' 2¾"	66' 6"	52' 0"	120 @ 29'	1,500'	45° 0'	2,900	
0' 11½"	69' 2"	54' 0"	30' 4½"	1,500'	45° 0'	3,150	
34' 0"	43' 4"	25' 0"	22' 6"	311' 9"	44° 0'		
41' 5"	61' 9"	28' 0"	30' 0"	240' 0"	37° 30'	2,315	Storage trestle 20,000 tons capacity

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4—Standard gage railroad to mill.
5—Extra heavy primary crushing plant to 2-inch size.
6—Dry magnetic separators in closed circuit with 72 x 20-inch rolls, reducing to about ⅛-inch size and discarding about 50 per cent of the material as hard waste rock of all intermediate sizes, suitable for concrete work, road building and railroad ballast. A shipping concentrate can also be taken out here and shipped without further treatment if desired.
7—Ball mills grinding the ⅛-inch partly concentrated material wet to 80 to 100 mesh.
8—Wet magnetic separators, Davis type.
9—Sintering plant.

No one of these operations is novel or untried. Each is in successful use somewhere else, with costs and results well known. The quarry, railroad and coarse crushing end of this plant will be in operation in the late fall of 1920 if labor and railroad conditions permit. The entire plant should be in production during the entire season of 1921. It is being built on the unit basis, so that additional capacity may be added at will up to almost any amount desired.

Table Showing Shipments of Lake Superior Iron Ore

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Mayville
1854*	73,553	.....	.....	.....	.....	.....
1854	3,000	.....	.....	.....	.....	.....
1855	1,449	.....	.....	.....	.....	.....
1856	6,790	.....	.....	.....	.....	.....
1857	25,646	.....	.....	.....	.....	.....
1858	22,876	.....	.....	.....	.....	.....
1859	68,832	.....	.....	.....	.....	.....
1860	114,401	.....	.....	.....	.....	.....
1861	49,909	.....	.....	.....	.....	.....
1862	124,169	.....	.....	.....	.....	.....
1863	203,055	.....	.....	.....	.....	.....
1864	247,059	.....	.....	.....	.....	.....
1865	198,758	.....	.....	.....	.....	.....
1866	296,713	.....	.....	.....	.....	.....
1867	465,504	.....	.....	.....	.....	.....
1868	506,505	.....	.....	.....	.....	.....
1869	649,097	.....	.....	.....	.....	.....
1870	856,245	.....	.....	.....	.....	.....
1871	818,966	.....	.....	.....	.....	.....
1872	938,384	.....	.....	.....	.....	.....
1873	1,162,918	.....	.....	.....	.....	.....
1874	932,241	.....	.....	.....	.....	.....
1875	895,945	.....	.....	.....	.....	.....
1876	992,536	.....	.....	.....	.....	.....
1877	1,012,152	10,405	.....	.....	.....	.....
1878	1,037,678	82,824	.....	.....	.....	.....
1879	1,131,038	247,135	.....	.....	.....	.....
1880	1,384,010	560,950	.....	.....	.....	.....
1881	1,579,834	738,987	.....	.....	.....	.....
1882	1,829,394	1,170,819	.....	.....	.....	.....
1883	1,305,425	1,078,551	.....	.....	.....	.....
1884	1,558,034	896,282	1,022	62,124	.....	.....
1885	1,430,422	692,950	119,590	225,484	.....	.....
1886	1,627,380	892,148	753,362	304,396	.....	.....
1887	1,851,417	1,196,043	1,322,875	394,252	.....	.....
1888	1,923,733	1,191,101	1,437,096	511,953	.....	.....
1889	2,642,814	1,796,754	1,988,394	844,782	.....	.....
1890	2,993,664	2,282,237	2,847,911	880,014	.....	.....
1891	2,512,242	1,824,619	1,841,580	894,618	.....	.....
1892	2,665,169	2,261,499	2,973,077	1,167,650	4,245	9,044
1893	1,837,580	1,466,197	1,329,385	820,621	613,620	7,925
1894	2,060,260	1,137,949	1,809,468	948,513	1,793,052	10,511
1895	2,097,838	1,923,798	2,547,976	1,077,838	2,781,587	16,472
1896	2,604,221	1,560,467	1,799,971	1,088,090	2,882,079	13,144
1897	2,715,035	1,937,013	2,258,236	1,278,481	4,275,809	10,546
1898	3,125,039	2,522,265	2,498,462	1,265,142	4,613,766	18,151
1899	3,757,010	3,301,052	2,795,856	1,771,502	6,626,384	19,731
1900	3,457,522	3,261,221	2,875,296	1,655,820	7,809,535	20,986
1901	3,245,346	3,619,053	2,938,155	1,786,063	9,004,890	22,400
1902	3,868,025	4,612,509	3,654,930	2,084,263	13,342,840	23,338
1903	3,040,245	3,749,567	2,938,937	1,676,699	12,913,742	36,749
1904	2,843,703	3,074,848	2,399,419	1,282,513	12,156,008	46,120
1905	4,215,572	4,495,451	3,705,688	1,677,186	20,158,699	60,588
1906	4,057,187	5,109,088	3,642,160	1,792,355	23,819,029	77,471
1907	4,388,073	4,964,728	3,633,459	1,685,267	27,495,708	23,610
1908	2,414,632	2,679,156	2,699,856	841,544	17,257,350	71,341
1909	4,256,172	4,875,385	4,088,058	1,108,215	28,176,281	82,559
1910	4,392,726	4,237,738	4,315,314	1,203,177	29,194,534	91,682
1911	2,833,116	3,911,174	2,603,319	1,088,930	22,093,532	115,629
1912	4,202,308	4,711,440	5,006,266	1,844,981	32,047,409	104,031
1913	3,966,680	4,965,604	4,531,558	1,566,600	34,038,643	145,010
1914	2,491,857	3,221,258	3,568,482	1,016,993	21,465,967	105,765
1915	4,105,378	4,982,626	5,477,767	1,733,595	29,756,689	80,583
1916	5,396,007	6,364,363	8,489,685	1,947,200	42,525,612	125,970
1917	4,874,150	6,045,750	7,981,684	1,530,692	41,445,211	93,997
1918	4,354,297	6,378,698	7,936,701	1,192,908	40,396,711	88,812
1919	2,992,212	4,442,868	6,230,839	929,049	31,997,699	92,819
Total	131,731,148	120,474,570	117,041,834	43,179,510	520,686,631	1,615,184

* Prior to 1854.

Totals from Opening of Each Range to Date

Michipicoten	Baraboo	Moose Mt.	Cuyuna	Total	Year
.....	.....	.....	.....	73,553	*1854
.....	.....	.....	.....	3,000	1854
.....	.....	.....	.....	1,449	1855
.....	.....	.....	.....	6,790	1856
.....	.....	.....	.....	25,646	1857
.....	.....	.....	.....	22,876	1858
.....	.....	.....	.....	68,832	1859
.....	.....	.....	.....	114,401	1860
.....	.....	.....	.....	49,909	1861
.....	.....	.....	.....	124,169	1862
.....	.....	.....	.....	203,055	1863
.....	.....	.....	.....	247,059	1864
.....	.....	.....	.....	198,758	1865
.....	.....	.....	.....	296,713	1866
.....	.....	.....	.....	465,504	1867
.....	.....	.....	.....	506,505	1868
.....	.....	.....	.....	649,097	1869
.....	.....	.....	.....	856,245	1870
.....	.....	.....	.....	818,966	1871
.....	.....	.....	.....	938,384	1872
.....	.....	.....	.....	1,162,918	1873
.....	.....	.....	.....	932,241	1874
.....	.....	.....	.....	895,945	1875
.....	.....	.....	.....	992,536	1876
.....	.....	.....	.....	1,022,557	1877
.....	.....	.....	.....	1,120,502	1878
.....	.....	.....	.....	1,378,173	1879
.....	.....	.....	.....	1,944,960	1880
.....	.....	.....	.....	2,318,821	1881
.....	.....	.....	.....	3,000,213	1882
.....	.....	.....	.....	2,383,976	1883
.....	.....	.....	.....	2,517,463	1884
.....	.....	.....	.....	2,468,446	1885
.....	.....	.....	.....	3,577,286	1886
.....	.....	.....	.....	4,764,587	1887
.....	.....	.....	.....	5,063,883	1888
.....	.....	.....	.....	7,272,744	1889
.....	.....	.....	.....	9,003,826	1890
.....	.....	.....	.....	7,073,059	1891
.....	.....	.....	.....	9,080,684	1892
.....	.....	.....	.....	6,075,323	1893
.....	.....	.....	.....	7,759,753	1894
.....	.....	.....	.....	10,445,509	1895
.....	.....	.....	.....	9,947,972	1896
.....	.....	.....	.....	12,475,120	1897
.....	.....	.....	.....	14,042,825	1898
.....	.....	.....	.....	18,271,535	1899
65,000	.....	.....	.....	19,145,380	1900
232,531	.....	.....	.....	20,848,483	1901
302,510	.....	.....	.....	27,888,415	1902
203,119	.....	.....	.....	24,559,058	1903
118,355	47,922	.....	.....	21,968,888	1904
169,527	71,413	.....	.....	34,554,124	1905
121,556	67,118	.....	.....	38,685,964	1906
142,832	72,180	.....	.....	42,405,857	1907
148,421	51,108	2,557	.....	26,165,965	1908
170,065	.....	26,199	.....	42,783,134	1909
115,790	.....	71,784	.....	43,622,745	1910
148,627	.....	6,749	147,431	32,948,507	1911
48,838	.....	39,061	305,111	48,309,445	1912
62,484	.....	102,238	733,021	50,111,838	1913
178,930	.....	29,457	859,404	32,938,113	1914
328,331	.....	49,444	1,136,113	47,641,526	1915
225,081	93,411	5,338	1,716,218	66,888,885	1916
264,833	42,635	.....	2,422,834	64,701,836	1917
161,011	9,245	23,777	2,478,800	63,023,960	1918
163,008	.....	4,896	1,861,165	48,714,555	1919
3,370,849	455,032	355,500	11,660,147	950,570,405	

* Prior to 1854

Chapter VII

METHOD OF MIXING ORE FOR SHIPMENT OF UNIFORM GRADES

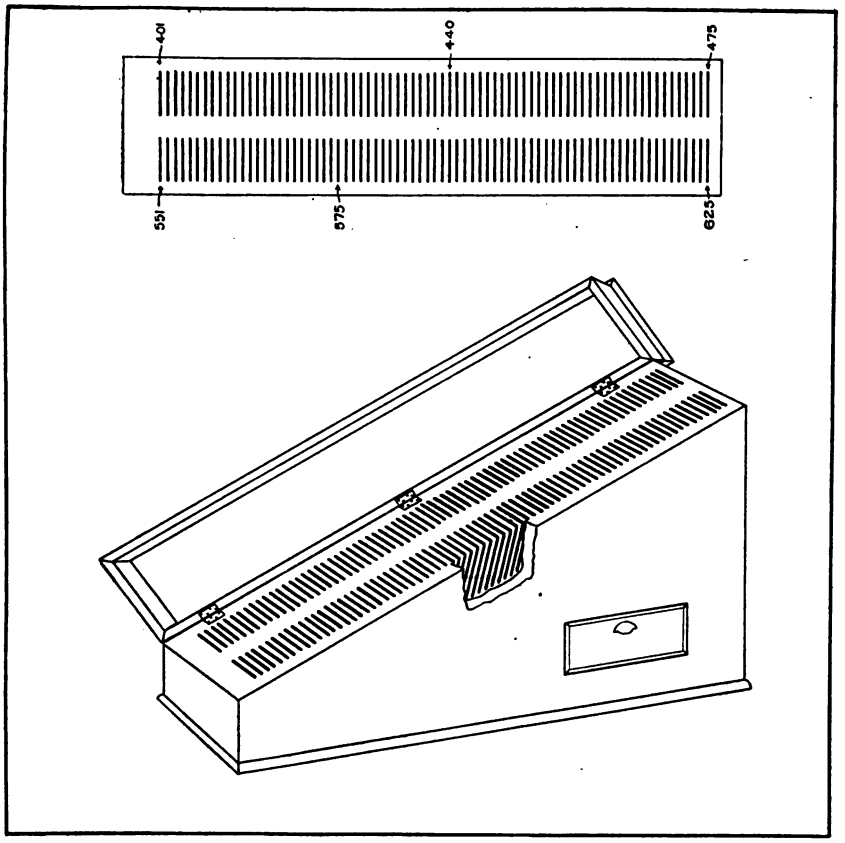
By H. D. Leech, Oglebay, Norton & Co.

In recent years the various industries of the country have placed production on a more scientific basis, rather than continue with the "hit or miss" methods formerly in use, resulting not only in higher production and lower operating costs, but in a uniformity or standardization of output. In line with this tendency in all industries, there also has been a change from the old-time plan of operating a blast furnace, which was more or less approximate, to the modern, exact method, by which all raw materials are carefully weighed and burdens mixed in accordance with calculations based on chemical analysis.

The cause underlying this change in blast furnace practice, is a demand on the part of manufacturers for iron and steel of certain definite chemical properties intended for a special use, and from which only slight deviation is permitted, as for example, the demands of the railroads for heavier and better rails upon which to carry the ever increasing size of railroad equipment, and the special and uniform high-grade steels required by the automobile industry, which must conform to certain chemical and physical tests.

As the quality of the iron depends very largely upon its contents of silicon, sulphur, phosphorus, manganese and carbon elements most of which are contained in the ore, the chemical analysis of the ore must be carefully considered. It is almost without exception, found that any one kind of ore by itself is unsuited to blast furnace requirements, but by mixing with other ores the resulting mixture makes a grade which comes within the specifications and is suitable for the production of a certain kind of finished product. It is also found frequently that ore even from the same mine varies more or less in some of its elements, and in order to ship a uniform grade it is necessary to pay close attention to the mixing of the ore from such properties. If these mixtures were made at the blast furnace, it would, in many instances, require a number of stockpiles of different ores, and would entail considerable time and expense in making the mixtures; therefore, it has been found more advantageous to have these grades mixed at the loading docks at the upper lake ports, this plan being more carefully developed each year.

As it is, of course, impracticable to analyze each buggy of ore going into the furnace, it is necessary that a sample from a larger body of material be taken and analyzed and this analysis



Card Record of Loading Docks

used as representative of the entire body. Therefore, it is extremely important that this larger body should be uniform throughout, so that the sample taken will be truly representative. In many instances the ore when unloaded at the lower lake dock is immediately shipped to the furnace and unloaded into the bins and from there charged directly into the furnace, and the analysis as determined from the sample taken at the lower lake dock is the one upon which the burden is calculated. Should there be any sudden or radical departure from the grade there would be a possibility of serious difficulty in the operation of the furnace.

The importance of uniformity in ores has been fully realized by the shippers of Lake Superior iron ores, and great care is being taken by them to ship grades that are uniform at all times, both chemically and physically and in accordance with the requirements of the blast furnaces.

The method of mixing of ores in use by the mining companies which we represent, has been tried out successfully and found not only to produce an ore of uniform grade, but also to be entirely practical in its operation, and it has been highly gratifying to the mining companies, as well as to the consumers of ore to find that the analyses made at the mine and by the independent chemists at lower lake ports, and by the chemists at the furnace, all check very closely, indicating that the method which has been adopted for careful mixing in the loading pockets is proving of great value in promoting uniformity of ores.

The method operates as follows: Cars of approximately 40 tons capacity of each definite grade constituting the mixture are sampled in the usual manner of taking car samples at the mine, and analysis made of five car lots, and this analysis represents the analysis of each car in the lot, and record is made of such analysis and each car number.

At the mine office is kept a carefully made box containing slots representing the pockets of the loading dock, each slot bearing a number corresponding to the pocket in the dock, as shown in the illustration. The approximate proportion or number of cars of each grade that should go into each pocket having been previously determined in order to make the grade desired, upon the arrival of a train of ore at the dock the representative of the mining company stationed there makes certain that the ore is distributed along the dock into pockets allotted for the cargo in the proper proportions of each grade, until each pocket contains four or five cars. This, where the capacity of the pocket is six cars. He then telephones the mine office the car numbers of the cars placed in each pocket and they enter the car numbers and analysis of each car on a card, together with the number of the pocket. These cards are then placed in the box in the slots corresponding to the pocket of the loading dock. They then figure the average of the ore in each pocket from these cards and if it is found that any one is above or below the grade desired the representative at the dock is given instructions to dump into the pocket a certain car, the analysis of which will bring the average of ore in that pocket to the grade desired. Thus when the boat is loaded, all pockets show approximately the same analysis. The last one or two cars dumped into each pocket are the adjusting or balancing cars. Different colored cards are used for different grades being made up, so that it can be determined at a glance just what grades are in the dock.

The cards bearing the car numbers and analysis of each car in each pocket are kept in the corresponding slot in the box until the pocket has been emptied. They are then filed together, by cargoes, so that at all times it can be ascertained the car numbers and analysis of the cars which made up each cargo.

Chapter VIII

METHODS OF ANALYSES

Preparation of the Sample

The standard sample as received at the laboratory is thoroughly dried and put through a Gates crusher, until the whole sample will pass a ¼-inch sieve. The sample is then thoroughly mixed and quartered through a Braun quartering machine three times. The final quartering is put through steel rolls until it will all pass a 20-mesh sieve. This entire sample is then mixed and quartered once through the Braun machine. One-half of the sample is thoroughly mixed and spread out on glazed paper. With a steel spatula, two 3-ounce tin boxes are filled by dipping the ore from a number of places. These two boxes of ore are then thoroughly mixed and divided into two equal portions. One part is put through a 100-mesh sieve and is used for analysis; the other part is retained in a box for check determination.

Moisture

The ore samples are received from the boats in tightly covered tin cans. The sample for analysis weighs about 35 pounds, and that for moisture about 20 pounds. The entire moisture sample is emptied into a shallow pan, 24 x 18 x 2 inches. The pan is first weighed and then the pan and wet ore weighed together. The pan of ore is placed on an enclosed steam coil and subjected to 212 degrees Fahr. heat for about 12 hours or until the weight is constant. The pan and ore are then weighed, and from the loss in weight the percentage of moisture is calculated.

The sample for analysis is treated in the same way, and the moisture calculated. This is for an approximate check on the actual moisture determination.

Before analysis, the entire sample is dried for one hour at 100 degrees Cent., removed from the ovens and kept in a desiccator.

IRON—Weigh ½ gram of the ore into a 150 c. c. beaker, add 10 c. c. of a mixture concentrated hydrochloric acid 3 parts, and stannous chloride 1 part, cover with a watch glass and heat slowly to boiling on a hot plate, agitating the solution. After boiling for one minute, the beaker is removed to a warm place on the hot plate and left standing until the solution is complete. When the residue in the beaker appears perfectly white, reduce with stannous chloride from a burette, until the solution becomes colorless, and add two drops excess. Add 10 c. c. mercuric chloride solution, and wash the contents of the beaker into a titration jar containing 100 c. c. to 150 c. c. of cold distilled water and 25 c. c. of the manganous sulphate mixture. Titrate with potassium permanganate to the first pink color. The perman-

ganate should be of such strength that 1 c. c. equals 0.005 gram of iron, or every c. c. should correspond to 1 per cent of iron, when ½ gram portion of the ore is taken.

SOLUTIONS

Permanganate of Potassium

112.3 grams dissolved in 43 litres of water.

Manganous Sulphate

480 gram manganous sulphate, 10,700 c. c. water, 1 litre phosphorus acid (85 per cent) and 2,800 c. c. strong sulphuric acid.

Permanganate Solution Values

1 c. c. equals 0.005000 gram iron.
1 c. c. equals 0.002500 gram lime.
1 c. c. equals 0.001473 gram manganese.
1 c. c. equals 0.000814 gram phosphorus.

Stannous Chloride

375 grams dissolved in 1 litre of water and 1 litre of strong hydrochloric acid.

Mercuric Chloride

700 grams dissolved in 14 litres of water.

PHOSPHORUS—For bessemer ores weigh 5 grams, and for nonbessemer ores, weigh 1 gram into a 250 c. c. beaker. Add 50 to 75 c. c. concentrated hydrochloric acid, cover with a watch glass and heat gradually to boiling, holding this temperature until the ore appears to be completely dissolved. Slightly raise the cover glass by means of a glass hook and evaporate the solution gradually until the mass becomes nearly dry; do not bake. Cool and add 15 c. c. of concentrated nitric acid. Heat gently until all the brown fumes are removed. Add 20 to 30 c. c. of hot water and filter into an Erlenmeyer flask of 500 to 600 c. c. capacity.

The residue, after having been washed six times with hot water, is ignited very strongly in a platinum crucible. The silica is volatilized with hydrofluoric acid, and the resultant residue is dissolved in hydrochloric acid. The contents of the crucible is washed into the beaker in which the original solution was made. Evaporate to 5 or 10 c. c., add 15 c. c. of concentrated nitric acid and heat gently until all the brown fumes are removed. Dilute with hot water and filter into the main filtrate, which has in the meantime been concentrated to a small bulk, about 20 to 30 c. c. To the solution, 25 c. c. of strong ammonia are added at once, and the flask is shaken until the resultant precipitate has curdled. This precipitate is dissolved by the addition of 25 c. c. of strong nitric acid. Heat to 80 degrees Cent. and add 40 c. c. molybdate solution. Agitate the solution for five minutes and then let it stand in a cool place for two hours. Filter, washing

precipitate four times with 2 per cent nitric acid and eight times with 1 per cent solution of potassium nitrate (10 g. pure KNO_3 dissolved in 1 litre H_2O), or to the removal of the last trace of free acid. The flask is thoroughly rinsed with water, and the filter and precipitate are transferred to it. Sufficient standard alkali to dissolve the precipitate is added, the solution is diluted, the flask closed by a rubber stopper and shaken until the precipitate has dissolved and the paper is disintegrated. Two or three drops of indicator are added and the standard acid solution is run in till the pink color has just disappeared. 1 c. c. NaOH = 1 c. c. HNO_3. One c. c. NaOH corresponds to 0.0023 per cent phosphorus, when a 5-gram portion of the ore is taken.

SOLUTIONS

Standard Caustic Soda

59.4 grams pure sodium hydrate dissolved in 18 litres of water.

Standard Nitric Acid

90 c. c. concentrated acid added to 18 litres of water.

Phenolphthalein

1 gram dissolved in 1 litre of ethyl alcohol.

Two Per Cent Nitric Acid

360 c. c. concentrated nitric acid added to 18 litres of water.

One Per Cent Potassium Nitrate

180 grams pure potassium nitrate dissolved in 18 litres of water.

Molybdate Solution

No. 1 solution. 3,750 c. c. of strong nitric acid are added to 6,000 c. c. water, mixed and cooled.

No. 2 solution. 750 grams molybdic acid (Merk's 85 per cent) are dissolved in a mixture of 1500 c. c. water and 1,500 c. c. strong ammonia, mixed and cooled. Add No. 2 solution slowly to No. 1 solution, passing a current of air through the solution to mix thoroughly. Let stand for 48 hours before using.

MANGANESE—Three grams of the ore are dissolved by gentle heating, in 75 c. c. of concentrated hydrochloric acid in a 500 c. c. beaker, covered with a watch glass. When the solution is complete add 1 c. c. of nitric acid and 25 c. c. of dilute sulphuric acid, and hasten the evaporation by raising the watch glass slightly. Evaporate to the white fumes of sulphuric acid. Cool and add 150 to 200 c. c. of water, and heat to boiling. Boil five minutes and cool. When cool, transfer the solution to a graduated cylinder, add zinc oxide suspended in water, continuously shaking the solution until there is a slight excess, shown by the

yellowish appearance of the precipitate formed. Dilute with water to exactly 600 c. c. in the graduated cylinder, mix the contents thoroughly by shaking, and filter. Of the filtrate take two portions, each 200 c. c., and place in Florence flasks, 500 c. c. capacity. Heat to boiling and titrate while boiling with potassium permanganate. One c. c. equals 0.001473 gram manganese, or corresponds to 0.1473 per cent manganese if 1 gram of the ore is taken.

SOLUTION

Permanganate of Potassium

122.3 grams dissolved in 43 litres of water.

SILICA—Weigh 1 gram into a 5-inch evaporating dish, add 40 c. c. concentrated hydrochloric acid, and evaporate to hard dryness on the hot plate. Take up in 30 c. c. dilute hydrochloric acid (1-1), boil a few minutes, filter through a 16-centimeter fine paper, catching the filtrate in a 250 c. c. beaker. The residue is transferred to the paper and the evaporating dish scrubbed out and washed into filter. The residue and paper is washed twice, with hot dilute hydrochloric acid (1-1) and followed by six washings with hot water. The filtrate is boiled down to about 60 c. c. and then transferred to the original evaporating dish and baked to hard dryness. Take up in 30 c. c., dilute hydrochloric acid (1-1), boil, filter and wash as above. Both filter papers are placed in a platinum crucible and the residue burned off on the blast. The crucible is now cooled and weighed. Add 6 c. c. of hydrofluoric acid and 4 drops of dilute sulphuric acid. Place in a sand bath and evaporate to dryness. Add a small amount of hydrofluoric acid and evaporate to dryness again. The crucible is now heated to red heat and then cooled and weighed. The difference in weight is the silica.

ALUMINA—To the filtrate from the silica, add about 1 c. c. nitric acid and heat to boiling. Add strong ammonia in very slight excess, boil a minute and filter while hot. Wash thoroughly with hot water. Dissolve the precipitate on the paper with hot dilute hydrochloric acid, reprecipitate with ammonia, filter and wash. The filtrates are used for lime determinations. The precipitate on the paper is dissolved with boiling hot dilute hydrochloric acid into 600 c. c. beaker. Add strong ammonia with constant stirring until a deep mahogany color is obtained. If a precipitate is formed add a drop or two of dilute hydrochloric acid, until it is dissolved, then add ammonia to the proper color. Add 3.3 c. c. of concentrated hydrochloric acid, 10 c. c. of a 10 per cent ammonium phosphate solution, and 30 c. c. of a sodium hyposulphite solution, equivalent to 10 grams of the salt, followed by 5 c. c. of glacial acetic acid. Cover and heat gradually

to boiling, with occasional stirring, and boil 15 minutes. Filter with moderate suction and wash eight times with boiling water. Ignite in a weighed porcelain crucible, and weigh as aluminum phosphate. The weight times 0.4185 equals the weight of alumina.

SOLUTION

Ammonium Phosphate

100 grams dissolved in 1 litre of water.

LIME—The filtrate from the iron and alumina hydrates is evaporated to 150 or 200 c. c. and 10 c. c. of a saturated solution of ammonium oxalate added while boiling. Add 10 c. c. of strong ammonia and boil 10 minutes. Allow to stand in a warm place for two hours until completely settled, then filter through double papers, washing eight times with hot water. Ignite in a weighed platinum crucible, finishing in a blast until the weight is constant. Cool in a desiccator and weigh as lime.

SOLUTION

Ammonium Oxalate

50 grams dissolved in 1 litre of water.

MAGNESIA—The filtrate from the calcium oxalate in the lime determination is made slightly acid with hydrochloric acid. Add 10 c. c. of ammonium phosphate solution. Cool and add drop by drop with constant stirring 25 c. c. of concentrated ammonium hydrate and continue stirring a few minutes. Let stand in a cool place six hours, filter and wash with water containing 10 per cent ammonia and 5 per cent ammonium nitrate. Ignite in a porcelain crucible and weigh as magnesium pyrophosphate. Factor for magnesia is 0.3624.

SOLUTION

Ammonium Phosphate

225 grams dissolved in 1 litre of water.

SULPHUR—One gram of the ore is thoroughly mixed with 10 grams of sodium carbonate and 1 gram of potassium nitrate. The mixture is heated carefully in a capacious platinum crucible, over a blast lamp, until the fusion is quiet, then at the highest temperature of the lamp for a few minutes. The crucible is protected from contamination with sulphur in the gas by an asbestos shield. The fusion is thoroughly disintegrated in hot water, filtered and washed with hot water. The filtrate is made slightly alkaline with ammonia, again filtered and thoroughly washed. Two drops of methyl orange are added to the filtrate, and hydrochloric acid is added until the solution is just acid. After bringing to a boil 10 c. c. of barium chloride solution is added and the solution boiled for five minutes. After standing in a warm place for three hours the solution is filtered, washed with hot water,

ignited in a platinum crucible, and weighed as barium sulphate, 13.74 per cent of the weight being sulphur.

SOLUTION

Barium Chloride

100 grams dissolved in 1 litre of water.

LOSS ON IGNITION—One gram of the ore is placed in a weighed platinum crucible with a tightly fitting cover and heated to a bright red heat over a Bunsen burner for 15 minutes. Cool in a desiccator and weigh. Heat five minutes more and weigh, repeat until the weight remains constant. The loss in weight is the "Loss on Ignition."

Chapter IX

RECORD OF AVERAGE ORE ANALYSES

The following tables showing the average analyses of Lake Superior iron ores, compiled by W. L. Tinker, secretary of the Lake Superior Iron Ore association, represent the actual quantitative average analyses of 97 per cent of all ore shipped during the years 1902 to 1919 inclusive. The method of calculation used in working out these tables was as follows: To determine the average iron content, the tonnage of each grade was multiplied by the percentage of iron in the ore. By adding the units of iron thus obtained in the ores of a given group and dividing the result by the total tons the average iron content was obtained. The elements of phosphorus, silica, manganese and moisture were determined in the same manner.

In summarizing his report on the analyses, Mr. Tinker points out that the average yearly decrease in the average iron content of the ores from 1909 to 1919 was as follows: Gogebic range, 0.03 per cent; Marquette, 0.162 per cent; Vermilion, 0.189 per cent; Mesabi, 0.009 per cent. The Menominee range ores show an average annual increase of metallic iron of 0.062 per cent, due in large part to the drop in the tonnage of silicious ores. The average yearly decrease in the average iron content from 1909 to 1919, including all the ores of the Lake Superior district in the calculation, was 0.028 per cent.

AVERAGE ANALYSES OF BESSEMER ORES

Gogebic

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
1919.....	2,626,868	53.62	.042	8.68	.36	10.81	44.9
1918.....	3,103,885	53.40	.042	8.46	.36	10.88	39.4
1917.....	2,940,287	53.70	.042	8.44	.38	10.93	39.3
1916.....	3,872,291	53.82	.041	7.98	.36	11.13	46.3
1915.....	2,440,584	54.18	.040	7.64	.37	10.84	45.3
1914.....	2,067,627	54.48	.039	7.14	.36	11.01	58.8
1913.....	2,866,116	54.21	.040	7.29	.34	11.06	65.6
1912.....	3,001,643	54.26	.041	7.51	.40	10.85	61.4
1911.....	1,648,501	54.72	.040	6.49	.39	10.95	68.4
1910.....	3,132,902	54.18	.041	7.12	.38	11.05	73.0
1909.....	2,671,996	53.87	.042	7.25	.42	11.86	67.6
1908.....	1,833,331	53.99	.039	7.30	.35	10.77	68.7
1907.....	2,478,298	53.85	.041	6.97	.41	11.11	69.5
1906.....	2,793,241	54.21	.041	6.70	.40	11.00	77.5
1905.....	3,073,937	54.97	.041	5.70	.43	11.05	85.1
1904.....	1,960,165	55.21	.040	5.61	.48	10.70	82.0
1903.....	2,275,548	55.92	.039	5.14	.49	10.72	79.5
1902.....	2,649,273	55.76	.042	4.88	.46	10.88	78.2
1919.....	313,703	56.56	.035	8.08	.16	7.99	11.9
1918.....	650,406	56.03	.037	8.03	.14	6.79	15.3
1917.....	781,952	52.83	.038	8.12	.24	9.11	17.1
1916.....	690,283	54.90	.037	8.91	.24	8.98	13.1

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
			Marquette				
1915	566,601	55.27	.039	8.21	.26	9.08	14.4
1914	372,185	54.10	.038	8.62	.32	10.00	15.5
1913	467,247	53.54	.038	9.21	.35	10.35	12.2
1912	503,342	55.18	.040	7.79	.26	10.37	12.8
1911	696,062	54.40	.038	9.01	.34	10.10	25.0
1910	879,124	55.48	.044	8.87	.29	8.93	20.7
1909	884,978	57.59	.045	6.94	.20	8.36	21.6
1908	698,036	56.04	.045	7.31	.25	9.26	29.3
1907	890,249	56.97	.045	7.39	.22	8.10	22.0
1906	774,983	57.46	.046	6.87	.24	8.01	19.3
1905	1,059,980	57.56	.046	6.60	.19	7.76	25.6
1904	784,542	58.54	.043	5.61	.39	7.41	28.2
1903	1,072,978	58.18	.045	5.38	.32	8.16	35.9
1902	1,054,757	58.26	.042	5.42	.36	8.26	27.6
			Menominee				
1919	211,332	51.05	.043	8.40	.25	6.51	4.8
1918	303,265	51.06	.044	7.73	.25	6.64	4.8
1917	461,013	51.99	.045	7.69	.23	6.89	7.9
1916	177,979	53.06	.040	8.51	.18	7.93	2.9
1915	126,507	55.20	.035	8.64	.07	6.95	2.7
1914	59,380	56.96	.026	6.75	.09	7.10	2.0
1913	107,837	55.34	.029	7.92	.10	6.97	2.3
1912	85,389	55.21	.025	10.21	.07	7.03	2.0
1911	105,643	54.56	.033	8.42	.04	7.34	2.8
1910	159,575	55.02	.044	11.20	.03	7.54	3.8
1909	292,031	53.84	.042	9.40	.13	7.40	6.0
1908	93,649	55.53	.034	10.24	.03	7.46	3.4
1907	161,765	56.61	.034	8.40	.19	7.30	3.4
1906	234,732	55.90	.036	8.82	.13	7.39	4.7
1905	160,727	56.80	.032	7.42	.13	7.59	3.6
1904	102,381	57.54	.027	6.42	.13	7.78	3.4
1903	104,669	57.79	.021	7.45	.13	7.97	2.9
1902	86,018	57.71	.017	5.73	.16	8.31	2.0
			Vermilion				
1919	719,444	58.26	.039	6.21	.12	6.64	82.5
1918	928,336	57.61	.040	7.24	.15	6.44	80.2
1917	1,109,688	58.06	.040	6.67	.13	6.35	74.8
1916	1,466,702	57.68	.040	7.12	.11	6.53	76.1
1915	1,391,816	57.94	.039	6.56	.15	6.71	81.6
1914	741,224	58.48	.039	6.14	.13	6.51	73.8
1913	1,200,674	58.81	.039	5.87	.12	6.28	77.6
1912	1,369,602	59.31	.038	5.78	.11	5.78	75.0
1911	890,419	59.59	.038	5.92	.11	5.27	82.8
1910	933,147	60.11	.038	5.03	.10	5.29	78.2
1909	896,690	60.32	.039	4.88	.12	5.35	81.7
1908	698,693	60.44	.039	4.45	.13	5.44	83.9
1907	1,545,834	60.14	.037	5.16	.11	5.55	92.7
1906	1,595,321	60.13	.039	4.87	.09	5.73	89.3
1905	1,413,007	60.61	.039	4.41	.13	5.55	85.7
1904	1,199,684	60.01	.040	4.63	.12	5.39	94.5
1903	1,403,998	60.48	.041	4.66	.12	5.24	84.6
1902	1,639,108	61.55	.040	4.12	.13	4.71	80.1
			Cuyuna				
1919	62,496	53.86	.039	9.97	.06	10.86	3.5
1918	111,636	53.83	.043	9.95	.09	10.50	4.6
1917	127,106	54.19	.042	9.81	.07	10.06	5.7
1916	68,867	53.23	.044	10.25	.11	10.86	4.8
			Total, Old Range				
1919	3,933,843	54.57	.041	8.18	.29	9.59	25.3
1918	5,097,528	54.37	.041	8.17	.28	9.29	23.2
1917	5,420,046	54.33	.041	8.00	.29	9.37	25.1
1916	6,276,122	54.81	.041	7.92	.28	9.72	27.1
1915	4,525,508	55.50	.039	7.41	.28	9.24	27.1
1914	3,240,416	55.39	.039	7.07	.30	9.79	30.6
1913	4,641,874	55.36	.039	7.13	.28	9.65	32.1
1912	4,959,976	55.76	.040	7.11	.30	9.34	33.1
1911	3,340,625	55.95	.039	6.93	.30	9.15	33.4
1910	5,104,748	55.52	.041	7.17	.30	9.52	36.6
1909	4,745,695	55.78	.042	6.88	.30	9.70	33.8
1908	3,323,709	55.82	.040	6.67	.27	9.24	38.5
1907	5,076,146	56.40	.041	6.54	.28	8.76	36.1
1906	5,398,277	56.50	.041	6.28	.27	8.86	37.4
1905	5,707,651	56.90	.041	5.59	.31	8.98	41.3
1904	4,046,772	57.34	.040	5.34	.34	8.41	42.7
1903	4,857,193	57.78	.040	5.10	.34	8.51	43.7
1902	5,429,156	58.03	.041	4.77	.34	8.47	39.9

Mesabi

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
1919	11,104,863	53.74	.044	7.45	.51	10.68	35.7
1918	14,266,072	53.65	.044	7.42	.53	10.57	35.7
1917	15,093,216	53.17	.044	7.41	.55	11.09	36.9
1916	15,605,590	53.10	.046	7.54	.54	11.24	37.1
1915	10,471,532	52.90	.043	8.31	.56	10.76	35.9
1914	8.011,373	52.62	.045	8.00	.55	11.03	38.5
1913	13,763,900	53.31	.044	7.11	.57	11.21	41.1
1912	13,996,278	53.25	.047	7.40	.56	10.37	45.3
1911	10,608,310	52.81	.046	7.90	.54	10.66	49.3
1910	12,971,239	53.42	.046	7.11	.64	10.76	45.6
1909	12,318,334	53.46	.044	6.57	.63	11.23	44.1
1908	9,584,716	54.08	.044	6.14	.59	10.87	56.0
1907	16,376,333	54.17	.046	5.47	.55	11.14	62.6
1906	15,372,105	54.66	.044	5.37	.51	10.92	66.3
1905	13,914,139	55.35	.042	4.74	.50	10.77	70.1
1904	9,306,695	56.32	.040	4.45	.50	9.81	77.9
1903	9,541,328	55.86	.040	4.75	.50	10.02	74.9
1902	10,613,878	56.67	.039	4.14	.52	9.58	80.7

Total Bessemer

1919	15,038,706	53.96	.043	7.64	.45	10.40	32.2
1918	19,363,600	53.84	.043	7.62	.46	10.23	31.2
1917	20,513,262	53.48	.043	7.57	.48	10.64	32.8
1916	21,881,712	53.59	.044	7.65	.47	10.80	33.6
1915	14,997,040	53.68	.042	8.04	.48	10.30	32.7
1914	11,251,789	53.42	.043	7.73	.48	10.68	35.8
1913	18,405,774	53.83	.043	7.11	.49	10.82	38.4
1912	18,956,254	53.91	.045	7.33	.49	10.10	41.3
1911	13,948,935	53.56	.044	7.67	.48	10.30	44.3
1910	18,075,987	54.01	.045	7.12	.54	10.41	42.7
1909	17,064,029	54.10	.044	6.66	.54	9.15	40.7
1908	12,908,425	54.28	.043	6.31	.51	10.45	50.1
1907	21,452,479	54.70	.045	5.72	.49	10.58	53.3
1906	20,770,382	55.14	.043	5.60	.45	10.33	55.3
1905	19,621,790	55.80	.042	4.99	.45	10.25	58.3
1904	13,353,467	56.63	.040	4.72	.45	9.39	62.1
1903	14,308,521	56.51	.040	4.87	.44	9.51	60.2
1902	16,048,034	57.13	.040	4.35	.46	9.21	59.9

NOTE—In working out these tables, ores containing not more than .001 per cent of phosphorus, dried, to each unit of iron in the natural condition were classed as bessemer.

LOW-PHOSPHORUS, NONBESSEMER ORES

(Phosphorus .130 and under)

Gogebic

Year	Tonnage	Iron (Natural)	Phos.	Silica	Man	Moisture	Per cent of total
1919	2,723,117	53.23	.030	6.55	.4	12.17	46.5
1913	3,292,113	52.94	.039	6.80	.50	12.53	49.9
1917	3,807,237	53.07	.038	6.85	.43	12.27	50.9
1916	3,954,565*	53.28	.036	7.00	.51	12.05	47.2
1915	2,660,648	53.91	.089	6.58	.55	11.57	49.4
1914	1,268,584	53.88	.095	6.74	.41	11.77	36.1
1913	1,295,766	53.20	.080	7.91	.47	11.41	29.7
1912	1,603,518	53.44	.084	8.30	.44	11.13	32.9
1911	613,739	52.98	.086	8.47	.48	11.67	25.5
1910	827,685	52.13	.090	9.45	.43	11.72	19.3
1909	972,103	51.72	.032	8.78	.58	11.95	24.6
1908	642,604*	52.44	.091	8.19	.57	12.38	24.1
1907	644,560*	52.39	.088	8.14	.58	12.14	18.1
1906	446,893	52.23	.116	8.60	.65	11.98	12.4
1905	345,161	52.06	.119	9.38	.53	11.61	9.6
1904	329,004	52.56	.070	8.34	.59	11.52	13.8
1903	499,800	52.12	.091	7.53	.58	10.24	14.3
1902	517,504	53.05	.033	8.98	.63	10.49	15.3

Marquette

1919	1,629,533	52.30	.098	8.88	.33	10.54	61.8
1918	2,999,819	52.34	.099	8.95	.42	10.08	70.6
1917	2,722,581	52.60	.100	8.09	.40	10.41	59.6
1916	3,445,875	52.53	.099	7.94	.43	10.13	65.5
1915	2,818,786	53.40	.098	8.26	.41	10.32	71.6

Marquette—(*Continued*)

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
1914.....	1,646,300	52.72	.103	7.55	.47	9.71	68.8
1913.....	2,862,994	52.61	.099	8.22	.42	9.87	74.7
1912.....	2,676,002	53.03	.106	7.44	.38	10.32	68.3
1911.....	1,630,439	52.54	.106	8.50	.46	10.52	58.7
1910.....	2,653,220	51.44	.100	8.11	.42	9.89	62.4
1909.....	2,617,998†	52.81	.088	8.16	.46	9.04	63.8
1908.....	1,311,113	52.54	.094	8.36	.40	10.32	55.1
1907.....	2,581,474	53.29	.091	8.52	.44	9.38	63.9
1906.....	2,712,798	54.30	.100	7.56	.44	9.37	67.7
1905.....	2,670,859	54.51	.108	7.25	.40	9.20	64.5
1904.....	1,806,517	54.82	.107	6.64	.44	8.92	64.8
1903.....	1,538,529	54.82	.114	6.97	.36	9.09	51.4
1902.....	2,325,731	55.39	.108	6.67	.34	7.63	60.8
			Menominee				
1919.....	846,857	50.72	.074	9.77	.23	7.17	19.3
1918.....	1,200,981	51.16	.069	9.71	.23	7.11	19.1
1917.....	1,238,142	52.09	.067	8.56	.23	7.25	21.1
1916.....	1,345,883	53.04	.067	7.84	.20	6.98	21.8
1915.....	1,182,076	52.31	.079	7.78	.21	6.91	24.8
1914.....	798,910	51.97	.077	9.48	.21	7.25	27.1
1913.....	1,385,571	51.35	.079	8.70	.23	6.91	29.5
1912.....	1,169,346	51.55	.078	10.55	.19	6.71	26.9
1911.....	760,540	52.53	.074	9.31	.16	7.44	20.4
1910.....	1,206,788	51.97	.072	9.47	.24	7.30	28.7
1909.....	1,310,372	52.80	.070	7.82	.17	7.38	26.7
1908.....	733,064	51.97	.066	10.67	.20	6.99	26.7
1907.....	1,576,960	52.00	.069	10.57	.30	7.15	32.9
1906.....	1,673,227	53.01	.066	9.50	.30	6.71	33.2
1905.....	1,705,970	53.67	.070	8.96	.29	6.64	38.5
1904.....	1,107,922	54.69	.071	6.95	.29	7.14	36.5
1903.....	1,570,709	54.24	.067	7.59	.32	6.90	43.7
1902.....	1,973,850	54.31	.070	7.93	.29	7.21	45.4
			Vermilion				
1919.....	152,617	60.19	.151	8.76	.10	2.14	17.5
1918.....	229,338	59.10	.135	9.62	.12	2.82	19.8
1917.....	373,260	57.89	.100	10.17	.19	3.74	25.2
1916.....	459,630	58.81	.100	8.91	.09	3.77	23.9
1915.....	312,973	58.39	.107	8.24	.09	4.34	18.4
1914.....	262,946	58.80	.110	7.06	.12	4.36	26.2
1913.....	347,158	58.63	.098	8.10	.11	4.08	22.4
1912.....	457,332	58.78	.100	7.00	.11	4.72	25.0
1911.....	185,116	59.60	.112	6.41	.09	4.09	17.2
1910.....	259,268	60.25	.112	5.71	.11	4.08	21.8
1909.....	200,437	61.24	.113	4.70	.11	3.75	18.3
1908.....	134,231	61.22	.092	5.06	.10	3.58	16.1
1907.....	122,215	63.94	.108	4.04	.08	1.93	7.3
1906.....	190,550	64.58	.086	3.51	.09	1.81	10.7
1905.....	235,603	64.33	.097	4.18	.12	1.36	14.3
1904.....	70,005	66.47	.131	2.85	.10	.71	5.5
1903.....	255,934	62.98	.089	3.93	.12	2.70	15.4
1902.....	406,784	62.00	.100	3.26	.08	2.75	19.9
			Cuyuna				
1919.....	226,727	52.36	.068	9.17	.27	11.65	12.8
1918.....	385,246	48.18	.127	8.73	.62	12.06	16.1
1917.....	516,233	50.81	.130	9.98	.46	11.47	23.3
1916.....	337,645	51.14	.114	8.55	.28	12.46	23.8
1915.....	274,412	50.35	.175	8.18	.30	11.90	30.6
1914.....	325,170	51.85	.073	9.29	.21	12.49	44.1
			Total, Old Range				
1919.....	5,578,851	52.74	.111	7.89	.37	10.64	35.9
1918.....	8,747,503	52.44	.092	8.10	.43	10.67	39.8
1917.....	8,657,453	52.85	.092	7.82	.38	10.55	40.0
1916.....	9,526,093	53.17	.089	7.61	.41	10.25	41.1
1915.....	7,248,895	53.51	.095	7.56	.41	10.03	43.4
1914.....	4,301,910	53.23	.094	7.77	.36	9.59	40.6
1913.....	5,891,489	52.80	.090	8.25	.37	9.17	40.8
1912.....	5,911,198	53.29	.094	8.25	.33	9.39	39.5
1911.....	3,189,834	53.03	.094	8.56	.36	9.63	31.9
1910.....	4,946,961	52.14	.090	8.54	.36	9.26	35.5
1909.....	5,034,621	52.97	.083	8.15	.36	8.92	35.8
1908.....	2,735,258	52.83	.083	8.73	.36	9.46	31.7
1907.....	4,919,187	53.03	.083	9.04	.40	8.83	35.0
1906.....	5,023,468	54.08	.090	8.14	.40	8.43	34.8
1905.....	4,957,593	54.52	.095	7.84	.35	8.11	35.8
1904.....	3,313,448	54.80	.092	6.84	.39	8.40	34.9
1903.....	3,774,972	54.84	.090	7.08	.35	7.87	34.0
1902.....	5,223,869	55.26	.091	7.11	.33	7.42	38.4

Mesabi

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
1919	19,092,807	50.35	.078	7.87	.82	12.77	61.3
1918	25,176,874	50.19	.078	7.68	.88	12.89	62.9
1917	25,043,735	50.22	.078	7.50	.84	13.33	61.2
1916	26,098,801	49.21	.077	7.65	.90	13.42	62.1
1915	18,521,286	49.55	.079	7.77	.79	13.31	63.4
1914	12,546,529	49.66	.081	7.43	.82	13.20	60.2
1913	19,288,838	49.37	.076	7.73	.86	13.44	57.6
1912	16,752,682	49.48	.079	7.44	.86	13.19	54.2
1911	10,879,763	49.47	.079	7.60	.89	13.09	50.6
1910	15,081,459	49.75	.081	7.29	.84	13.19	53.1
1909	15,244,270	50.12	.076	6.52	.90	13.68	54.6
1908	7,513,481	50.85	.077	6.34	.84	13.37	43.9
1907	9,654,461	50.94	.080	5.35	.74	13.11	36.9
1906	7,629,141	50.97	.083	6.04	.79	13.22	32.9
1905	5,932,490	51.62	.070	5.12	.71	13.06	29.9
1904	2,645,470	52.40	.070	5.02	.67	11.84	22.1
1903	3,171,423	53.19	.065	4.74	.58	11.45	25.1
1902	2,546,936	53.55	.066	5.23	.54	10.26	19.3
Total Low-Phosphorus Nonbessemer							
1919	24,671,658	50.89	.086	7.88	.72	12.29	52.9
1918	33,924,377	50.77	.082	7.79	.76	12.32	54.7
1917	33,701,188	50.90	.082	7.58	.73	12.62	53.9
1916	35,618,894	50.26	.080	7.64	.77	12.57	54.6
1915	25,770,181	50.67	.083	7.71	.68	12.39	56.2
1914	16,848,439	50.57	.084	7.52	.70	12.28	53.6
1913	25,180,327	50.17	.079	7.85	.75	12.44	52.6
1912	22,663,880	50.48	.083	7.65	.70	12.20	49.4
1911	14,069,597	50.28	.082	7.82	.78	12.31	44.7
1910	20,028,420	50.34	.084	7.60	.73	12.22	47.3
1909	20,278,891	50.83	.078	6.93	.77	12.49	48.3
1908	10,248,739	51.38	.078	6.90	.72	12.31	39.8
1907	14,573,648	51.64	.081	6.60	.63	11.67	36.3
1906	12,652,609	52.20	.086	6.88	.64	11.31	33.6
1905	10,890,083	52.94	.082	6.36	.56	10.81	32.3
1904	5,958,918	53.73	.082	6.02	.52	9.94	27.8
1903	6,946,395	54.09	.079	6.01	.46	9.50	29.3
1902	7,770,805	54.70	.082	6.48	.39	8.35	29.1

*Includes small tonnage above .180 phos.
†Includes small tonnage above 2.00 manganese.

HIGH-PHOSPHORUS, NONBESSEMER ORES

(Phosphorus above .180)

Marquette

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
1919	318,846	51.89	.628	5.08	.59	11.36	12.1
1918	241,068	51.79	.545	6.14	.54	11.24	5.7
1917	716,695	51.04	.392	7.02	.65	13.40	15.7
1916	594,451	51.96	.438	6.71	.67	12.69	11.3
1915	251,648	50.93	.528	7.72	.60	12.35	6.4
1914	137,749	49.98	.354	7.35	.44	12.07	5.8
1913	278,824	51.03	.400	7.05	.49	12.21	7.3
1912	448,757	49.88	.623	7.12	.79	14.42	11.4
1911	168,830	48.51	.400	8.35	.39	12.96	6.1
1910	418,625	48.78	.454	8.51	.44	12.98	9.8
1909	299,829	47.16	.378	9.97	.35	12.52	7.3
1908	232,337	48.13	.341	8.73	.28	12.96	9.7
1907	392,668	49.48	.440	8.65	.55	13.91	9.7
1906	339,403	51.74	.422	7.68	.56	13.36	8.5
1905	218,644	50.95	.477	7.17	.37	11.57	5.3
1904	68,690	50.88	.420	6.27	.31	11.47	2.5
1903	212,498	48.33	.342	8.39	.21	8.18	7.1
1902	204,394	49.43	.325	6.82	.23	8.50	5.3
Menominee							
1919	3,136,693	51.03	.476	7.50	.34	8.52	71.5
1918	4,179,419	51.02	.464	7.18	.35	8.73	66.4
1917	3,527,892	51.10	.460	6.86	.34	8.78	60.1
1916	3,743,367	51.09	.441	7.16	.34	8.64	60.7
1915	2,814,498	51.21	.465	7.15	.32	8.56	59.1
1914	1,563,990	51.39	.492	7.14	.32	8.50	53.0

Menominee—(*Continued*)

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
1913	2,383,665	50.22	.470	8.31	.31	8.44	50.8
1912	2,305,025	50.45	.475	8.30	.32	8.54	53.1
1911	1,952,485	50.88	.488	7.31	.34	8.14	52.5
1910	2,291,607	50.44	.472	7.99	.37	8.19	54.5
1909	2,684,998	50.31	.490	8.01	.35	8.38	54.7
1908	1,403,299	50.58	.439	7.87	.37	7.98	51.2
1907	1,952,222	51.21	.494	6.31	.46	8.67	40.7
1906	1,960,418	51.51	.520	5.08	.47	9.05	38.9
1905	1,630,223	51.57	.525	6.01	.43	8.47	36.8
1904	1,188,615	52.84	.512	5.44	.42	8.43	39.1
1903	986,523	52.70	.474	5.50	.50	8.46	27.5
1902	1,404,270	52.15	.436	6.12	.41	8.51	32.3
			Cuyuna				
1919	1,192,528	49.58	.247	8.58	.47	11.55	67.1
1918	782,694	50.42	.249	8.60	.37	9.92	32.6
1917	1,211,702	49.92	.245	7.94	.73	10.24	54.6
1916	587,762	50.81	.216	8.66	.36	11.02	41.3
1915	623,370	49.93	.246	9.45	.59	10.24	69.4
1914	411,403	48.70	.287	10.60	.32	10.87	55.9
			Total				
1919	4,648,067	50.72	.428	7.61	.39	9.49	29.9
1918	5,203,181	50.97	.435	7.35	.36	9.03	23.7
1917	5,456,289	50.83	.403	7.12	.47	9.71	25.2
1916	4,949,085	51.17	.413	7.28	.38	9.44	21.4
1915	3,689,516	50.97	.432	7.57	.39	9.10	22.1
1914	2,113,142	50.78	.443	7.83	.32	9.20	19.9
1913	2,662,489	50.30	.463	8.18	.33	8.83	18.4
1912	2,753,782	50.40	.499	8.11	.38	9.50	18.4
1911	2,121,315	50.69	.481	7.39	.34	8.52	21.2
1910	2,710,232	50.18	.470	8.07	.38	8.93	19.4
1909	2,984,827	49.99	.479	8.20	.35	8.80	21.1
1908	1,721,390	50.29	.413	8.03	.36	8.95	20.0
1907	2,350,902	50.92	.484	6.70	.47	9.56	16.7
1906	2,299,821	51.54	.506	5.46	.49	9.68	15.9
1905	1,848,867	51.49	.520	6.15	.42	8.83	13.4
1904	1,257,305	52.73	.507	5.49	.41	8.59	13.3
1903	1,199,021	51.92	.451	6.01	.45	8.41	10.8
1902	1,608,664	51.81	.421	6.21	.39	8.51	11.8

MANGANIFEROUS ORES

(Manganese 2.00 and over)

Gogebic

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
1919	477,964	48.57	.073	7.44	3.13	13.70	8.1
1918	785,865	48.38	.074	8.73	3.24	12.95	9.9
1917	654,006	48.94	.071	9.58	4.00	10.93	8.7
1916	545,550*	48.43	.062	9.34	3.66	12.15	6.5
1915	256,588	43.64	.065	10.35	3.52	10.94	4.8
1914	182,554	49.44	.063	10.19	3.10	10.84	5.2
1913	208,310	48.92	.055	12.78	3.13	8.81	4.7
1912	232,124	49.89	.053	10.55	2.79	9.00	5.8
1911	138,446	50.28	.052	10.43	2.95	10.23	5.7
1910	326,717	49.12	.058	11.41	3.93	8.77	7.6
1909	288,464	47.76	.053	11.47	4.92	9.02	7.2
1908	183,511	48.64	.053	11.87	3.87	9.25	6.8
1907	421,106	50.45	.050	8.12	3.88	10.31	11.8
1906	363,254	50.33	.049	7.95	3.66	10.50	10.1
1905	194,497	50.20	.045	5.69	4.64	11.65	5.4
1904	99,857	50.62	.061	7.06	3.83	9.94	4.2
1903	178,653	50.25	.065	5.68	5.20	9.80	6.2
1902	222,141	52.33	.045	7.21	3.54	11.50	6.5
			Menominee				
1919	151,113	42.41	.525	6.46	7.76	7.27	3.4
1918	280,502	44.45	.541	7.20	5.35	7.29	4.5
1917	280,682	43.74	.511	7.43	6.80	7.32	4.8
1916	495,712	45.82	.588	7.25	4.01	7.31	8.0
1915	427,630	45.84	.580	7.48	3.90	7.27	9.0
1914	170,274	45.68	.620	7.58	3.69	7.39	5.8
1913	375,037	46.12	.582	7.20	3.61	7.16	8.0
1912	411,125	46.29	.577	7.60	3.37	7.16	9.5

Menominee—(*Continued*)

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
1911.....	285,662	46.42	.574	7.02	3.49	7.84	7.7
1910.....	118,659	46.52	.593	6.90	3.21	7.63	2.8
1909.....	147,523	47.07	.568	6.70	2.93	7.14	3.0
1908.....	80,257	45.32	.546	7.46	5.03	6.47	2.9
1907.....	210,762	45.71	.605	6.34	4.82	7.35	4.4
1906.....	186,502	45.76	.604	4.68	5.75	6.60	3.7
1905.....	70,076	47.50	.575	4.75	4.25	7.50	1.6
1904.....	45,338	47.50	.600	5.25	4.00	7.00	1.5
1903.....	157,157	47.50	.570	4.50	4.00	7.85	4.4
1902.....	46,900	48.37	.570	4.83	4.71	7.50	1.1
			Cuyuna				
1919.....	295,515	39.20	.227	7.92	9.88	11.58	16.6
1918.....	1,120,214	36.83	.205	11.00	10.56	12.44	46.7
1917.....	355,222	35.89	.199	10.28	12.21	12.71	16.4
1916.....	427,370	41.86	.201	9.86	6.99	10.91	30.1
			Total, Old Range				
1919.....	924,592	44.57	.196	7.43	6.04	11.97	6.0
1918.....	2,186,581	41.96	.201	9.75	7.26	11.96	9.9
1917.....	1,299,910	44.15	.202	9.31	6.91	10.65	6.0
1916.....	1,460,730	45.66	.281	8.68	4.76	10.17	6.3
1915.....	684,218	46.89	.387	8.55	3.76	8.64	4.1
1914.....	352,828	47.62	.332	8.93	3.38	9.18	3.3
1913.....	583,347	47.12	.394	9.19	3.44	7.75	4.0
1912.....	693,249	47.75	.364	8.80	3.13	7.91	4.6
1911.....	424,108	47.68	.404	8.13	3.31	8.62	4.2
1910.....	445,376	48.43	.200	10.21	3.74	8.47	3.2
1909.....	502,276	47.77	.207	8.72	3.98	8.87	3.6
1908.....	264,884	47.60	.202	10.58	4.22	8.41	3.1
1907.....	631,868	48.86	.235	7.53	4.20	9.32	4.5
1906.....	549,756	48.78	.238	6.84	4.37	9.17	3.8
1905.....	264,573	49.49	.186	5.44	4.54	10.55	1.9
1904.....	145,195	49.65	.229	6.50	3.88	9.02	1.5
1903.....	335,810	48.96	.302	5.14	4.64	8.89	3.0
1902.....	269,131	51.64	.137	4.79	3.74	10.80	2.0
			Mesabi				
1919.....	807,708	48.56	.080	7.19	2.41	13.09	2.6
1918.....	426,554	57.78	.073	8.39	3.27	11.25	1.1
1917.....	321,395	47.61	.068	8.88	3.20	12.13	.8
1916.....	333,595	48.15	.092	8.24	2.49	12.03	.8
1915.....	196,802	48.38	.097	7.97	2.34	12.90	.7
1914.....	269,462	50.36	.078	7.37	3.96	11.90	1.3
1913.....	298,797	49.02	.089	6.67	2.77	12.98	.9
1912.....	133,905	50.60	.063	10.07	2.43	9.53	.4
1911.....	26,019	47.78	.078	7.10	2.20	13.12	.1
1910.....	205,115	49.47	.074	5.52	2.35	13.08	.7
1909.....	214,034	49.91	.079	6.80	2.62	12.55	.8
1908.....							
1907.....	19,600	46.13	.048	8.00	4.94	11.62	.07
1906.....	167,293	53.73	.045	7.55	2.42	12.14	.7
			Total Manganiferous				
1919.....	1,732,300	46.43	.142	7.32	4.35	12.49	3.7
1918.....	2,613,135	42.91	.180	9.53	6.61	11.85	4.2
1917.....	1,621,305	44.84	.176	9.22	6.18	10.94	2.6
1916.....	1,794,325	46.13	.246	8.60	4.34	10.52	2.8
1915.....	881,020	47.22	.322	8.42	3.33	9.60	1.9
1914.....	622,290	48.81	.222	8.25	3.63	10.35	2.0
1913.....	882,144	47.43	.290	8.34	3.21	9.52	1.8
1912.....	827,154	48.22	.315	9.01	3.02	8.17	1.8
1911.....	450,129	47.68	.384	8.07	3.25	8.88	1.4
1910.....	650,491	48.76	.161	8.73	3.30	9.92	1.5
1909.....	716,310	48.41	.169	8.15	3.57	9.97	1.7
1908.....	264,884	47.60	.202	10.58	4.22	8.41	1.0
1907.....	651,468	48.78	.229	7.54	4.22	9.39	1.6
1906.....	717,049	49.93	.193	5.42	3.92	9.87	1.9
1905.....	264,573	49.49	.186	5.44	4.54	10.55	0.8
1904.....	145,195	49.65	.229	6.50	3.88	9.02	0.7
1903.....	335,810	48.96	.302	5.13	4.64	8.89	1.4
1902.....	269,131	51.64	.137	4.79	3.74	10.80	1.0

*Includes small tonnages of ore above 18.00 silica.

SILICIOUS ORES

(Silica 18.00 and over)

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
Gogebic							
1919	28,277	34.09	.045	40.40	.27	6.07	.5
1918	62,656	34.14	.041	36.28	.33	8.97	.8
1917	79,875	34.02	.043	41.19	.32	8.23	1.1.
1916							
1915	31,929	47.73	.093	25.47	.47	5.59	.6
1914–12							
1911	10,275	49.91	.022	20.71		6.95	.4
1910	1,958	42.38	.045	23.82	.37	12.00	.05
1909	18,939	42.12	.047	21.82	.40	9.88	.5
1908	10,042	49.22	.034	18.93	.21	9.04	.4
1907	24,287	47.62	.026	12.35	.38	8.85	.7
Marquette							
1919	374,104	40.32	.053	33.81	.50	5.59	14.2
1918	357,576	46.03	.068	30.43	.28	7.49	8.4
1917	349,700	41.68	.059	31.26	.49	5.92	7.6
1916	534,018	43.86	.059	27.28	.20	6.77	10.1
1915	300,902	41.07	.048	34.47	.57	4.32	7.6
1914	237,652	40.84	.052	36.00	.27	3.41	9.9
1913	223,254	41.21	.050	35.16	.17	3.04	5.8
1912	292,002*	42.97	.074	25.77	1.38	8.30	7.4
1911	284,364	43.37	.062	27.27	.73	6.52	10.2
1910	303,304	42.27	.065	30.95	.60	5.73	7.1
1909	300,601	42.59	.063	33.35	.22	3.72	7.3
1908	139,867*	42.16	.053	33.69	.19	4.07	5.9
1907	173,377	45.41	.052	27.73	.16	4.40	4.3
1906	180,605	44.87	.049	28.93	.18	4.05	4.5
1905	191,116	43.44	.056	29.93	.52	5.83	4.6
1904	126,526	42.51	.042	32.63	.37	3.83	4.5
1903	166,843	41.66	.056	33.72	.29	3.31	5.6
1902	240,812	39.11	.039	37.27	.32	2.75	6.3
Menominee							
1919	42,736	35.03	.024	37.16	.15	3.34	1.0
1918	330,639	36.92	.106	40.14	.10	3.58	5.3
1917	359,092	37.02	.089	40.05	.10	3.81	6.1
1916	405,967	37.49	.040	38.71	.10	4.28	6.6
1915	212,900	38.09	.014	37.29	.09	4.54	4.5
1914	360,784	37.34	.011	39.63	.10	4.40	12.2
1913	442,424	37.45	.016	38.70	.13	4.32	9.4
1912	370,151	37.46	.015	38.23	.12	4.76	8.5
1911	616,570	40.45	.027	31.89	.16	5.67	16.6
1910	426,800	37.77	.016	37.86	.16	4.78	10.2
1909	469,271	37.90	.014	37.95	.11	5.05	9.6
1908	432,339	38.97	.019	35.15	.11	5.70	15.8
1907	891,430	40.69	.038	32.30	.13	5.12	18.6
1906	980,392	39.59	.026	35.38	.17	4.49	19.5
1905	858,975	41.03	.024	33.67	.13	5.27	19.4
1904	594,577	40.68	.017	33.93	.11	5.75	19.6
1903	773,360	40.74	.018	30.62	.18	4.32	21.5
1902	839,655	41.33	.018	31.06	.19	3.94	19.3
Total, Old Range							
1919	445,117	39.42	.051	34.55	.46	5.40	2.9
1918	750,871	41.03	.082	35.19	.20	5.89	3.4
1917	788,667	38.78	.071	36.27	.29	5.19	3.7
1916	947,887	41.11	.051	32.19	.18	5.72	4.1
1915	545,731	40.30	.038	35.05	.38	4.48	3.3
1914	598,436	38.73	.027	38.19	.17	4.01	5.6
1913	665,678	38.71	.028	37.51	.14	3.89	4.7
1912	662,153	39.89	.041	32.76	.68	6.33	4.4
1911	911,209	41.47	.038	30.32	.34	5.95	9.2
1910	732,062	39.65	.036	34.96	.34	5.19	5.3
1909	788,811	39.79	.033	35.81	.16	4.66	5.6
1908	581,232	39.90	.027	34.54	.12	5.35	6.7
1907	1,089,094	41.60	.040	31.25	.14	5.09	7.7
1906	1,160,997	40.41	.029	34.38	.17	4.62	8.1
1905	1,050,091	41.46	.030	32.88	.19	5.37	7.6
1904	721,103	41.00	.022	33.70	.14	5.41	7.6
1903	940,203	40.91	.025	31.17	.20	4.14	8.5
1902	1,080,467	40.84	.023	32.58	.22	3.68	7.9

*Includes small tonnages of ore above 2.00 Mang.

Mesabi

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Moisture	Per cent of total
1919.....	131,030	46.86	.042	18.29	.46	10.66	.4
1918.....	117,707	46.40	.041	18.55	.42	11.08	.3
1917.....	440,754	46.67	.039	18.32	.37	10.94	1.1
1916–14.....							
1913.....	103,920	48.42	.037	18.44	.92	8.86	3.
1912–11.....							
1910.....	168,988	49.11	.024	20.46	.25	7.57	.6
1909.....	126,800	49.22	.030	19.34	.45	8.61	.5
1908.....	19,414	46.43	.031	19.10	.40	11.57	.1
1907.....	112,198	49.28	.034	19.10	.40	12.00	.4

Total, Silicious

1919.....	576,147	41.11	.049	30.85	.46	6.60	1.2
1918.....	868,578	41.76	.077	32.95	.23	6.59	1.5
1917.....	1,229,421	41.61	.060	29.83	.32	7.25	2.0
1916.....	947,887	41.11	.051	32.19	.18	5.72	1.5
1915.....	545,731	40.30	.038	35.05	.38	4.48	1.2
1914.....	598,436	38.73	.027	38.19	.17	4.01	1.9
1913.....	775,598	40.08	.029	34.81	.25	4.60	1.6
1912.....	662,153	39.89	.041	32.76	.68	6.32	1.4
1911.....	911,209	41.47	.038	30.32	.34	5.95	2.9
1910.....	901,050	41.48	.034	32.24	.32	5.64	2.1
1909.....	915,611	41.09	.033	33.53	.20	5.21	2.2
1908.....	600,646	40.12	.028	34.04	.13	5.55	2.3
1907.....	1,201,292	42.32	.039	30.21	.17	5.73	3.0
1906.....	1,160,997	40.41	.029	34.38	.17	4.62	3.1
1905.....	1,050,091	41.46	.030	32.88	.19	5.37	3.1
1904.....	721,103	41:00	.022	33.70	.14	5.41	3.4
1903.....	940,203	40.91	.025	31.17	.20	4.14	4.0
1902.....	1,080,467	40.84	.023	32.58	.22	3.68	4.0

*Includes small tonnage of ore above 2.00 Mang.

AVERAGES OF TOTAL, ALL GRADES

Gogebic

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Average Moisture
1919.....	5,856,226	52.95	.063	7.74	.63	11.66
1918.....	7,884,525	52.52	.069	7.88	.72	11.90
1917.....	7,481,405	52.75	.068	8.08	.72	11.58
1916.....	8,372,406	53.21	.064	7.60	.64	11.63
1915.....	5,889,749	53.74	.066	7.35	.61	11.18
1914.....	3,518,765	54.00	.061	7.15	.52	11.28
1913.....	4,370,192	53.66	.053	7.74	.51	11.05
1912.....	4,892,285	53.74	.055	7.94	.55	10.84
1911.....	2,410,961	54.00	.051	7.28	.57	11.08
1910.....	4,289,262	53.39	.050	7.90	.66	11.00
1909.....	3,951,502	52.83	.052	8.01	.78	11.66
1908.....	2,669,488	53.23	.052	7.87	.64	11.05
1907.....	3,568,251	53.14	.050	7.46	.85	11.18
1906.....	3,603,388	53.57	.051	7.06	.76	11.07
1905.....	3,613,595	54.43	.049	6.05	.67	11.14
1904.....	2,389,026	54.66	.045	6.05	.63	10.78
1903.....	2,864,001	55.02	.048	5.51	.80	10.60
1902.....	3,388,918	55.12	.048	5.50	.69	10.87

Marquette

1919.....	2,636,186	51.06	.148	11.87	.37	9.63
1918.....	4,248,869	52.31	.112	10.45	.37	9.42
1917.....	4,570,928	51.56	.132	9.70	.42	10.31
1916.....	5,264,627	51.90	.125	9.89	.41	9.93
1915.....	5,937,937	52.57	.113	10.22	.41	9.81
1914.....	2,393,886	51.60	.102	10.53	.42	9.26
1913.....	3,832,319	51.94	.111	9.82	.35	9.70
1912.....	3,920,103	52.50	.154	8.81	.49	10.65
1911.....	2,779,695	51.82	.102	10.54	.45	10.15
1910.....	4,254,273	51.36	.121	9.93	.40	9.70
1909.....	4,103,406	52.68	.098	9.88	.37	8.76
1908.....	2,381,453	52.53	.101	9.58	.33	9.90
1907.....	4,037,768	53.39	.113	9.11	.40	9.33
1906.....	4,007,789	54.27	.115	8.40	.40	9.20
1905.....	4,140,599	54.59	.110	8.13	.35	8.80
1904.....	2,786,275	55.21	.093	7.54	.41	8.32
1903.....	2,990,848	54.83	.102	7.99	.33	8.37
1902.....	3,825,694	54.84	.097	8.30	.34	7.61

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Average Moisture
		Menominee				
1919	4,388,731	50.52	.375	8.23	.57	8.07
1918	6,294,806	50.02	.353	9.42	.53	7.99
1917	5,866,821	50.16	.324	9.34	.60	7.94
1916	6,168,908	50.25	.333	9.43	.59	7.86
1915	4,763,611	50.52	.348	8.72	.60	7.81
1914	2,953,338	49.61	.319	11.76	.45	7.35
1913	4,694,534	49.14	.311	11.19	.53	7.46
1912	4,341,036	49.34	.330	11.44	.55	7.55
1911	3,720,900	49.25	.320	11.80	.51	7.54
1910	4,203,429	49.65	.298	11.54	.38	7.55
1909	4,904,195	49.90	.308	10.87	.34	7.70
1908	2,742,608	49.14	.263	12.99	.41	7.29
1907	4,793,129	49.46	.259	12.62	.53	7.40
1906	5,035,271	49.68	.254	12.61	.54	7.21
1905	4,425,971	50.46	.236	12.52	.37	7.10
1904	3,038,833	51.21	.239	11.60	.36	7.39
1903	3,592,418	50.72	.189	11.84	.50	6.85
1902	4,350,783	51.11	.179	11.82	.35	7.00
		Vermilion				
1919	872,061	58.60	.059	6.66	.12	5.85
1918	1,157,674	57.90	.057	7.71	.14	5.72
1917	1,482,948	58.02	.055	7.55	.14	5.69
1916	1,926,332	57.95	.054	7.55	.11	5.87
1915	1,704,789	58.02	.051	6.87	.14	6.28
1914	1,400,170	58.56	.058	6.38	.13	5.94
1913	1,546,832	58.77	.052	6.37	.12	5.78
1912	1,826,934	59.18	.054	6.09	.11	5.52
1911	1,075,535	59.59	.051	6.01	.11	5.07
1910	1,192,415	60.14	.054	5.18	.11	5.00
1909	1,097,127	60.49	.053	4.84	.11	5.62
1908	832,924	60.57	.048	4.55	.12	5.14
1907	1,668,049	60.42	.043	5.08	.10	5.28
1906	1,785,871	60.60	.044	4.73	.09	5.31
1905	1,648,610	61.14	.047	4.37	.13	4.95
1904	1,269,689	60.37	.045	4.53	.12	5.13
1903	1,659,932	60.86	.048	4.55	.12	4.85
1902	2,045,892	61.65	.052	3.95	.12	4.32
		Cuyuna				
1919	1,777,266	48.35	.292	8.60	1.99	11.54
1918	2,399,790	43.87	.200	9.85	5.15	11.47
1917	2,220,263	48.06	.199	8.92	2.52	10.92
1916	1,421,644	48.31	.179	9.07	2.32	11.32
1915	897,782	50.06	.224	9.06	.50	10.75
1914	736,573	50.09	.193	10.02	.27	11.59
		Total, Old Range				
1919	15,530,470	51.73	.191	8.62	.70	9.96
1918	21,985,664	51.10	.172	9.03	1.05	9.93
1917	21,622,365	51.68	.164	8.81	.77	9.85
1916	23,153,917	52.22	.156	8.70	.64	9.74
1915	16,693,868	52.79	.164	8.46	.51	9.37
1914	10.606,732	52.40	.151	9.32	.42	9.25
1913	14,444,877	52.28	.152	9.27	.45	8.96
1912	14,980,358	52.73	.161	8.96	.48	9.19
1911	9.987,091	52.23	.166	9.73	.66	8.86
1910	13,939,379	52.22	.147	9.39	.45	9.05
1909	14,056,230	52.36	.155	9.30	.46	8.92
1908	8,626,473	52.44	.132	9.65	.43	8.97
1907	14,067,197	52.82	.138	9.41	.53	8.66
1906	14,432,319	53.28	.139	9.08	.50	8.50
1905	13,828,775	54.01	.126	8.54	.41	8.41
1904	9,483,823	55.45	.122	8.06	.41	8.21
1903	11,107,199	54.45	.108	8.09	.47	7.92
1902	13,611,287	54.74	.104	8.05	.40	7.73
		Mesabi				
1919	31,136,408	51.50	.066	7.75	.75	12.03
1918	39,987,207	51.39	.066	7.63	.78	12.04
1917	40,899,100	51.25	.065	7.60	.75	12.47
1916	42,037,986	50.64	.065	7.61	.78	12.60
1915	29,189,620	50.74	.066	7.96	.72	12.39
1914	20,827,364	50.81	.067	7.65	.76	12.35
1913	33,461,455	50.97	.063	7.50	.76	12.51
1912	30,882,865	51.20	.064	7.44	.73	11.90
1911	21,514,092	51.12	.063	7.75	.72	11.90
1910	28,426,801	51.42	.065	7.27	.76	12.05
1909	27,903,438	51.59	.062	6.60	.79	12.56

Mesabi—(*Continued*)

Year	Tonnage	Iron (Natural)	Phos.	Silica	Mang.	Average Moisture
1908	17,117,611	52.66	.059	6.24	.70	11.95
1907	26,162,592	52.95	.058	5.48	.62	11.87
1906	23,168,539	53.44	.057	5.56	.62	11.68
1905	19,846,629	54.24	.051	4.86	.56	11.45
1904	11,952,165	55.45	.047	4.58	.54	10.26
1903	12,622,751	55.19	.047	4.75	.52	10.38
1902	13,165,814	56.07	.045	4.35	.52	9.71

Total, all Ranges

1919	46,666,878	51.57	.108	8.04	.73	11.34
1918	61,972,871	51.29	.104	8.12	.87	11.29
1917	62,521,465	51.40	.099	8.02	.76	11.57
1916	65,191,903	51.20	.097	8.00	.73	11.58
1915	45,883,488	52.49	.100	8.14	.64	11.29
1914	31,434,096	51.34	.095	8.21	.65	11.30
1913	47,906,332	51.37	.090	8.03	.66	11.44
1912	45,863,223	51.69	.096	7.93	.65	11.01
1911	31,501,183	51.47	.095	8.38	.64	10.93
1910	42,366,180	51.68	.092	7.97	.66	11.06
1909	41,959,668	51.85	.093	7.51	.68	11.33
1908	25,744,084	52.58	.083	7.39	.61	10.95
1907	40,229,789	52.91	.086	6.86	.59	10.75
1906	37,600,858	53.38	.088	6.91	.57	10.46
1905	33,675,404	54.14	.082	6.37	.50	10.20
1904	21,435,988	55.02	.080	6.12	.48	9.36
1903	23,729,950	54.84	.075	6.31	.50	9.23
1102	26,777,101	55.39	.075	6.23	.46	8.74

PRICES OF IRON ORE AT THE LOWER LAKE PORTS SINCE THE OPENING OF THE RANGES

	OLD RANGE		MESABI	
	Bessemer	Nonbessemer	Bessemer	Nonbessemer
1855	$10.00	$10.00		
1856	8.00	8.00		
1857	8.00	8.00		
1858	6.50	6.50		
1859	6.00	6.00		
1860	5.25	5.50		
1861	5.25	5.00		
1862	5.25	5.37		
1863	7.50	7.50		
1864	8.50	8.50		
1865	7.50	7.50		
1866	9.50	11.75		
1867	10.50	9.75		
1868	8.25	8.25		
1869	8.25	9.50		
1870	8.50	9.00		
1871	8.00	8.00		
1872	9.00	7.50		
1873	12.00	9.00		
1874	9.00	7.00		
1875	7.00	5.50		
1876	6.75	4.50		
1877	6.50	4.25		
1878	5.50	4.25		
1879	6.25	4.75		
1880	9.25	8.00		
1881	9.00	7.00		
1882	9.00	6.25		
1883	6.15	4.85		
1884	4.75	4.50		
1885	5.15	4.15		
1886	5.50	4.15		
1887	6.65	5.15		
1888	5.25	4.40		
1889	5.00	4.50		
1890	5.50	5.25		
1891	4.50	4.25		
1892	4.50	3.65		
1893	3.85	3.20	$ 3.00	
1894	2.75	2.50	2.35	
1895	2.90	2.25	2.15	$1.90
1896	4.00	2.70	3.50	2.25
1897	2.60	2.15	2.25	1.90
1898	2.75	1.85	2.25	1.75
1899	3.00	2.15	2.40	2.00
1900	5.50	4.25	4.50	4.00
1901	4.25	3.00	3.25	2.75
1902	4.25	3.25	3.25	2.75
1903	4.50	3.60	4.00	3.20
1904	3.25	2.75	3.00	2.50
1905	3.75	3.20	3.50	3.00
1906	4.25	3.70	4.00	4.50
1907	5.00	4.20	4.75	4.00
1908	4.50	3.70	4.25	3.50
1909	4.50	3.70	4.25	3.50
1910	5.00	4.20	4.75	4.00
1911	4.50	3.70	4.25	3.50
1912	3.75	3.00	3.50	2.85
1913	4.40	3.60	4.15	3.40
1914	3.75	3.00	3.50	2.85
1915	3.75	3.00	3.45	2.80
1916	4.45	3.70	4.20	3.55
1917	5.95	5.20	5.70	5.05
1918, to July 1	5.95	5.20	5.70	5.05
1918, July 1, to October 1	6.40	5.65	6.15	5.50
1918, After October 1	6.65	5.90	6.40	5.75
1919	6.45	5.70	6.20	5.55
1920	7.45	6.70	7.20	6.55

NOTE—The base unit for bessemer ores was introduced about 1897 and the guarantee was 56.70 per cent iron, natural. No guarantee was given on nonbessemer ores until 1899, when it was fixed at 54.56, iron, natural. In 1907 base ore decreased from 56.70 to 55.00 in bessemer ore and 52.80 to 51.50 in nonbessemer ore. In 1905 and 1906 the base unit for Mesabi nonbessemer was 53.00 per cent.

Chapter X

VALUATION OF LAKE SUPERIOR IRON ORES

In the fluctuations in the prices of Lake Superior iron ores during the past 67 years may be traced some interesting features of the development of the ranges. Comparisons show that prices in 1920 do not differ radically from those in the fifties. In the early days of the ranges the limited developed sources of supply, difficulties of production and transportation were the chief factors contributing to prices; today, with highly developed mining and transportation facilities, the increased demand and cost of labor are the determining elements. The price of Old Range bessemer ore was established for 1920 at $7.45 a ton, delivered at lower lake ports. This was but 55 cents a ton less than the price in 1856. Old range nonbessemer ore sold for $6.70 a ton, delivered at lower lake ports, in 1920, while the price was $6.50 in 1859.

In a booklet called "Exhibit of the Condition and Prospects of the Lake Superior Iron Company," issued in March, 1853, occurs this paragraph:

> "The ore lies mostly above the surface; and for excellence is generally of a uniform character and is blasted out like rock in vast masses. The cost of mining it for years to come will not exceed 10 cents per ton. At present prices, the ore is worth at Cleveland and Erie $10 per ton. Should its value at these places ever be reduced to $5 per ton, which is not at all probable, the business of the company even then would be highly profitable."

In 1856, the price dropped to $8, and in 1860 to $5.25 per ton, but by 1873 it was increased to $12 per ton for the bessemer and $9 per ton for the nonbessemer grades. The average prices for Marquette range ores from 1855 to 1877, in which latter year the first shipments of ore were made from the Menominee range, were $7.93 per ton for the bessemer and $7.62 per ton for the nonbessemer grades. From 1877 to 1884, in which latter year the first shipments were made from the Gogebic and Vermilion ranges, the average prices for Marquette and Menominee range ores were $7.52 per ton for the bessemer and $5.62 per ton for the nonbessemer ores.

In 1892, the Mesabi range commenced shipments and since that time it has been the dominating factor in the Lake Superior ore trade. It has provided an enormous tonnage of high grade ore that was easily accessible and while Mesabi range ore has been subject to a differential in price on account of its physical

character, it has been so cheaply mined that its effect on the price of Old Range ores has been apparent. When shipments were first made from the Mesabi range, it was at a time of universal low prices, and in 1895 the prices of Mesabi ores were $2.15 per ton for the bessemer and $1.90 per ton for the nonbessemer grades, the lowest prices ever reached. In 1920 the price of Mesabi bessemer ore was established at $7.20 a ton, and Mesabi nonbessemer at $6.55.

It will be noted on "Table of prices of iron ore at lower lake ports since the opening of the ranges" that until 1872 there was practically no difference in the prices of bessemer and nonbessemer ores, although in some instances nonbessemer sold for more than bessemer. Since 1872 bessemer ores have commanded a better price than nonbessemer ores. The difference between these two grades fluctuated from 80 cents in 1908, 1909, 1910, 1911, 1913 to 75 cents in 1912, 1914, 1915, 1916, 1917, and 70 cents in 1920. This differential is not so great as indicated, however, as the two grades are sold under different guarantees. The base unit for bessemer ores was introduced about 1897 and the guarantee was 56.70 per cent, iron, natural. No guarantee was given on nonbessemer ores until 1899 when it was fixed at 54.36 per cent, iron, natural. In 1905 and 1906 the base unit for Mesabi nonbessemer was 53.00 per cent. In 1907 base ores decreased from 56.70 to 55.00 for bessemer, and from 52.80 to 51.50 for nonbessemer ores.

There is a growing belief that the differential between bessemer and nonbessemer ores will be somewhat decreased in the future, and in this event it is probable that the guarantees, at least so far as the iron is concerned also will be lowered. The present guarantees were established in 1907, and represented a drop of 1.70 per cent from 56.70 per cent to 55.00 per cent, so as to more nearly conform to the ore delivered.

As shown in the tables of analyses of Lake Superior iron ores presented elsewhere in this book, the average production of bessemer ores in the Lake Superior district was 16,048,034 tons, or 59.9 per cent of the total of both bessemer and nonbessemer, in 1902. The percentage of bessemer ore produced decreased very rapidly from 1902 to 1915, when it was 32.7 per cent, and has remained fairly constant since then, being 32.2 per cent in 1920.

FIGURING THE PRICE OF LAKE SUPERIOR IRON ORES FROM ANALYSES

For many years the value of standard Old Range and Mesabi iron ores was arrived at by adding the freight rate to the Valley furnaces, to the price quoted per ton at Lake Erie ports on base ores, Old Range or Mesabi, and dividing this sum by the percentage of natural iron of such base ores. This gave a base

unit value for figuring the price of all other standard Old Range and Mesabi ores. By multiplying the natural iron in any particular ore by the base unit value of either Old Range or Mesabi ores, as the case may be, the selling price of such ore was obtained. Iron ore is mined, sold, transported, taxed and royalty paid, on the basis of 2,240 pounds to the ton.

In the case of bessemer ores, an addition or subtraction was made to provide for the percentage of phosphorus over or under the percentage of phosphorus in the base ore. At the present time and for several years, this deduction has been made according to a table of phosphorus values which has been established.

In 1907 the percentage of the base ore, both Old Range and Mesabi, was reduced to more nearly confrom to the average percentage of iron in the ores being brought down from the upper lakes. This change was thought to be more just to the furnace interests than by using the base percentage which had been established some years earlier, when the average yield of all ores shipped from the Lake Superior region was higher. The present percentages in iron natural and phosphorus dry of the base ores, are as follows:

1. Old Range bessemer ores, 55 per cent iron natural, and 0.045 per cent phosphorus dried at 212 degrees Fahr.
2. Old Range nonbessemer ores, 51.50 per cent iron natural.
3. Mesabi bessemer ores, 55 per cent iron natural and 0.045 per cent phosphorus, dried at 212 degrees Fahr.
4. Mesabi nonbessemer ores, 51.50 per cent iron natural.

To arrive at the base unit value, add 60 cents (an average freight rate to Valley furnaces on ores shipped from Lake Erie ports) to the base prices and divide this sum by the base natural iron.

Example:

Assuming the selling price of Class 1 ore is.....	$7.45
Add average freight rate	.60
	$8.05
Dividing this sum by the base natural iron, gives....	$0.14636

which is the base unit value.

Assuming the selling prices of Classes 1, 2, 3 and 4 to be $7.45, $7.20, $6.30 and $6.55 per ton, respectively, and figuring the values as above, the base unit values are found to be:

For Old Range bessemer ores.....	$0.14636
For Old Range nonbessemer ores.....	0.14175
For Mesabi bessemer ores.....	0.14182
For Mesabi nonbessemer ores.....	0.13883

These base unit values are used to determine the premiums or penalties to be added to or subtracted from the quoted selling prices of the base ores, in order to arrive at the actual value of

the ores which may contain more or less than the guaranteed per centages of natural iron of the base ores.

To figure the value of bessemer ores, the following tables are used. For ores analyzing under 55 per cent iron natural:

From 55% to 50% iron natural, the value of each unit is the base unit.
From 50% to 49% iron natural, the value is the base unit, increased 50%.
From 49% to 48% iron natural, the value is the base unit, increased 100%.
Less than 48% iron natural the value of each unit is 28c, or whatever figure is named in the ore contract.

For ores analyzing above 55 per cent iron natural:

From 55% to 56% iron natural, the value is the base unit increased 1 cent.
From 56% to 57% iron natural, the value is the base unit increased 2 cents.
From 57% to 58% iron natural, the value is the base unit increased 3 cents.
From 58% to 59% iron natural, the value is the base unit increased 4 cents.
From 59% to 60% iron natural, the value is the base unit increased 5 cents.
Over 60% iron natural, the value of each unit is the base unit value, or whatever figure is named in the contract.

The phosphorus adjustment is made according to the phosphorus table, as shown on page —

To figure the value of nonbessemer ores the following table is used:

Above 50% iron natural, the value is the base unit.
From 50% to 49% iron natural, the value is the base unit plus 50%.
From 49% to 48% iron natural, the value is the base unit plus 100%.
Less than 48% iron natural, the value of each unit is 28 cents, or whatever figure is named in the ore contract.

These calculations may be illustrated as follows:

Suppose the analysis of an Old Range bessemer ore is 48 per cent iron natural and 0.050 phosphorus, dried at 212 degrees Fahr., and that the base ore which is guaranteed to contain 55 per cent iron natural and 0.045 per cent phosphorus, dried at 212 degrees Fahr., is selling at $7.45 per ton, delivered at Lake Erie ports. The actual selling price would be calculated as follows:

From 55% to 50% equals 5 units, 5 times the base unit equals....	$0.73180
From 50% to 49% equals 1 unit, 1 times the base unit plus 50% equals	0.21954
From 49% to 48% equals 1 unit, 1 times the base unit plus 100% equals	0.29272
Penalty for iron	1.24406
Penalty for phosphorus (from table).....	.04500
Total penalty	1.28906

Equals $1.29 per ton.

This penalty subtracted from the base price of $7.45 gives $6.16 as the actual selling price of the ore.

Suppose the analysis of a Mesabi bessemer ore is 57.50 per cent iron natural and 0.043 per cent phosphorus, dried at 212 degrees Fahr., and that the base ore which is guaranteed to contain 55 per cent iron natural and 0.045 per cent phosphorus, dried at 212 degrees Fahr., is selling at $7.20 per ton.

The actual selling price would be calculated as follows:

From 55% to 56% equals 1 unit, 1 times base unit plus 1c equals..	$0.15182
From 56% to 57% equals 1 unit, 1 times base unit plus 2c equals..	0.16182
From 57% to 57.50% equals ½ unit, ½ (base unit plus 3c equals..	0.10091
Premium for iron	0.41455
Premium for phosphorus (from table)	0.01650
Total premium	0.43105

Equals $.43 per ton.

This premium added to the base price of $7.20 gives $7.63 as the actual selling price of the ore.

Suppose the analysis of an Old Range nonbessemer ore is 48 per cent iron natural and that the base ore which is guaranteed to contain 51.50 per cent iron natural is selling for $6.70 per ton, delivered at Lake Erie ports. The actual selling price could be calculated as follows:

From 51.50% to 50% equals 1½ unit, 1½ times base unit equals..	$0.21263
From 50% to 49% equals 1 unit, 1 times base unit plus 50% equals.	0.21263
From 49% to 48% equals 1 unit, 1 times base unit plus 100% equals	0.28350
Total penalty	$0.70876

Equals $.71 per ton.

This penalty subtracted from the base price, $6.70 per ton, gives $5.99 as the actual selling price of the ore.

Suppose the analysis of a Mesabi nonbessemer ore is 55 per cent iron natural and that the base ore which is guaranteed to contain 51.50 per cent iron natural is selling for $6.55 per ton, delivered at Lake Erie ports. The actual selling price would be calculated as follows:

From 51.50 per cent to 55 per cent equals 3½ units, 3½ times base unit equals $0.48591

This would be the total premium, and equals $.49 per ton.

This premium added to the base price of $6.55 gives $7.04 as the actual selling price of the ore.

In a manganiferous ore, up to 4 or 5 per cent, the manganese is usually calculated as a metal with the iron; that is, the total percentage of iron and manganese in the natural, are used as a per centage of iron in calculating the value of the ore. For ores with a higher percentage of manganese than 4 or 5 per cent, a special price is generally made.

Silicious ores, that is, ores containing 20 per cent or more silica, are generally sold for a special price.

Phosphorus Table

Percentage of Phosphorus	Rate of Progression	Phos. Values	Percentage of Phosphorus	Rate of Progression	Phos. Values
.070	.0200	.3500	.037	.0115	.0780
.069	.0195	.3300	.036	.0120	.0900
.068	.0190	.3105	.035	.0125	.1025
.067	.0185	.2915	.034	.0130	.1155
.066	.0180	.2730	.033	.0135	.1290
.065	.0175	.2550	.032	.0140	.1430
.064	.0170	.2375	.031	.0145	.1575
.063	.0165	.2205	.030	.0150	.1725
.062	.0160	.2040	.029	.0155	.1880
.061	.0155	.1880	.028	.0160	.2040
.060	.0150	.1725	.027	.0165	.2205
.059	.0145	.1575	.026	.0170	.2375
.058	.0140	.1430	.025	.0175	.2550
.057	.0135	.1290	.024	.0180	.2730
.056	.0130	.1155	.023	.0185	.2915
.055	.0125	.1025	.022	.0190	.3105
.054	.0120	.0900	.021	.0195	.3300
.053	.0115	.0780	.020	.0200	.3500
.052	.0110	.0665	.019	.0205	.3705
.051	.0105	.0555	.018	.0210	.3915
.050	.0100	.0450	.017	.0215	.4130
.049	.0095	.0350	.016	.0220	.4350
.048	.0090	.0255	.015	.0225	.4575
.047	.0085	.0165	.014	.0230	.4805
.046	.0080	.0080	.013	.0235	.5040
.045	.0000	.0000	.012	.0240	.5280
.044	.0080	.0080	.011	.0245	.5525
.043	.0085	.0165	.010	.0250	.5775
.042	.0090	.0255	.009	.0255	.6030
.041	.0095	.0350	.008	.0260	.6290
.040	.0100	.0450	.007	.0265	.6555
.039	.0105	.0555	.006	.0270	.6825
.038	.0110	.0665	.005	.0275	.7100

Rail Freights on Iron Ore from the Mines to Lake Shipping Points

Year	Marquette Range to Marquette from Ishpeming and Negaunee	Marquette Range to Marquette from Gwinn and Republic	Marquette Range to Escanaba	Menominee Range to Escanaba	Gogebic Range to Ashland	Mesabi & Cuyuna Ranges to Superior, Duluth & Two Harbors	Vermilion Range to Two Harbors from Ely	Vermilion Range to Two Harbors from Tower and Soudan
1855	$3.00							
1856	1.27							
1857	1.27							
1858	.87							
1859	.87							
1860	1.09							
1861	1.09							
1862	1.09							
1863	1.09							
1864	1.09							
1865	1.10							
1866	1.10		$1.55					
1867	1.10		1.80					
1868	1.10		1.80					
1869	1.10		1.85					
1870	1.10		1.85					
1871	.95		1.70					
1872	.84		1.70					
1873	.84		2.00					
1874	.84		2.00					
1875	.65		1.25					
1876	.55		1.15					
1877	.55		1.15					
1878	.55		1.15					
1879	.55		1.15					
1880	.55		1.25					
1881	.55		1.25					
1882	.55		1.25					
1883	.55		1.10					
1884	.40		.80					
1885	.45		.80					
1886	.55		.80					
1887	.55		.80	$0.85	$0.80			
1888	.45		.70	.75	.70			
1889	.45		.70	.75	.70			
1890	.45		.70	.75	.70			
1891	.45		.70	.70	.65			
1892	.40		.65	.70	.65	$0.80	$1.00	$0.90
1893	.40		.65	.70	.65	.80	1.00	.90
1894	.32		.52	.70	.65†	.80	1.00	.90
1895	.32		.52	.52	.52	.80	1.00	.90
1896	.32		.52	.52	.52	.80	1.00	.90
1897	.32		.52	.52	.52††	.80	1.00	.90
1898	.32		.40	.45	.45†††	.80	1.00	.90
1899	.25		.40	.40	.40	.80	1.00	.90
1900	.25		.40	.40	.40	.80	1.00	.90
1901	.25		.40	.40	.40	.80	1.00	.90
1902	.25		.40	.40	.40	.80	1.00	.90
1903	.25		.40	.40	.40	.80	1.00	.90
1904	.25		.40	.40	.40	.80	1.00	.90
1905	.32		.40	.40	.40	.80	1.00	.90
1906	.32		.40	.40	.40	.80	1.00	.90
1907	.32	$0.30	.40	.40	.40	.80	1.00	.90
1908	.32	.30	.40	.40	.40	.80	1.00	.90
1909	.32	.30	.40	.40	.40	.80	1.00	.90
1910	.32	.30	.40	.40	.40	.80	1.00	.90
1911	.32	.30	.40	.40	.40	.80	1.00	.90
1912	.30	.30	.40	.40	.40	.60	.60	.60
1913	.25	.30	.40	.40	.40	.60	.60	.60
1914	.30	.35	.45	.45	.45	.60	.60	.60
1915	.30	.35	.45	.45	.45	.55	.55	.55
1916	.30	.35	.45	.45	.45	.55	.55	.55
1917*	.30	.35	.45	.45	.45	.55	.55	.55
1918**	.34	.395	.51	.51	.51	.635	.635	.635
1919	.65	.75	.85	.85	.85	1.00	1.00	1.00
1920	.65	.75	.85	.85	.85	1.00	1.00	1.00

* July 27, 1917 the rates were increased to the 1918 rates
** June 25, 1918 the rates were increased to the 1919 rates

† The rate via the Wisconsin Central Ry. in 1894 was $0.52
†† The rate via the Wisconsin Central Ry. in 1897 was .45
††† The rate via the Wisconsin Central Ry. in 1898 was .40

The above figures include a dock handling charge of 5 cents per ton, beginning in 1914 at Escanaba, Marquette and Ashland, and in 1918 at Superior, Duluth and Two Harbors.

Lake Freight Rates on Iron Ore from Ports Named to Lake Erie

Year	Escanaba	Marquette	Ashland and other ports at head of Lake Superior
1855		$3.00	
1856		3.00	
1857		2.67	
1858		2.09	
1859		2.00	
1860		2.00	
1861		2.21	
1862		2.89	
1863		3.19	
1864		3.37	
1865		3.23	
1866	$3.77	4.17	
1867	3.28	2.98	
1868	2.44	3.11	
1869	2.43	3.21	
1870	2.40	3.06	
1871	2.07	2.83	
1872	2.50	3.59	
1873	2.74	2.44	
1874	No Shipment	3.84	
1875	No Shipment	2.87	
1876	No Shipment	2.54	
1877	No Shipment	1.40	
1878	.85	1.26	
1879	1.07	1.61	
1880	1.77	2.50	
1881	1.55	2.25	
1882	1.22	1.50	
1883	1.11	1.30	
1884	.98	1.21	
1885	.84	1.01	$1.20
1886	1.16	1.35	1.49
1887	1.49	1.75	2.11
1888	.97	1.22	1.34
1889	1.00	1.14	1.29
1890	.99	1.16	1.26
1891	.65	.95	1.00
1892	1.00	1.15	1.25
1893	.85	1.00	1.00
1894	.60	.80	.80
1895	.55	.75	.80
1896	.70	.95	1.05
1897	.45	.65	.70
1898	.45	.60	.60
1899	.50	.60	.60
1900	1.00	1.10	1.25
1901	.60	.70	.80
1902	.60	.70	.75
1903	.65	.75	.85
1904	.55	.60	.70
1905	.60	.70	.76
1906	.60	.70	.75
1907	.60	.70	.75
1908	.50	.60	.65
1909	.50	.60	.65
1910	.55	.65	.70
1911	.45	.55	.60
1912	.35	.45	.50
1913	.40	.50	.55
1914	.35	.45	.50
1915	.35	.45	.50
1916	.45	.55	.60
1917	.85	1.00	1.10
1918	.85	1.00	1.10
1919	.70	.82	.90
1920	.95	1.10	1.20

NOTE—These rates include the unloading charge from hold to rail of vessel at lower lake ports.

Chapter XI

DOCK EQUIPMENT

Iron Ore Unloading Docks at the Lower Lake Ports

ASHTABULA

Dock: Pittsburgh, Youngstown & Ashtabula R. R. Co.
Operating Company: Ohio & Western Pennsylvania Dock Co.
Superintendent: J. M. Amsden.
Description: The dock is equipped with six electric Hoover & Mason unloading machines with 6-ton automatic buckets and is operated double shift. It has an unloading capacity of 40,000 tons per 20-hour day, and the ore is weighed by machine hopper scales. The dock is equipped with one storage bridge with a 16-ton clam, and has a storage capacity of 800,000 tons.

Dock: Superior.
Operating Company: The Ashtabula & Buffalo Dock Co.
Manager: H. S. Pickands.
Superintendent: E. O. Whitney.
Description: The dock is equipped with four electric Huletts with 15-ton automatic buckets and is operated two or three shifts as required. It has an unloading capacity of 50,000 tons per 24-hour day. The ore is weighed by machine hopper scales. The dock is equipped with one storage bridge with 15-ton clam, and has a storage capacity of 1,000,000 tons.

Dock: The Pollock-Becker Co. (Formerly Union.)
Operating Company: The Pollock-Becker Co.
Manager: C. A. Williams.
Superintendent: J. M. Kennedy.
Description: The dock is equipped with four electric Hulett machines with 15-ton automatic buckets, and is operated double shift. It has an unloading capacity of 44,000 tons per 20-hour day, and the ore is weighed by machine hopper scales. The dock is equipped with one storage bridge with 17-ton clam, and has a capacity of 1,000,000 tons.

BUFFALO

Dock: Buffalo, Rochester & Pittsburgh.
Operating Company: Buffalo, Rochester & Pittsburgh R. R. Co.
Description: The dock is equipped with two hydraulic Hulett automatic unloaders, with 10-ton buckets, two Brown Hoist power shovels, and has an unloading capacity of 8000 tons per 10-hour day. It is usually operated double shift. The

ore is weighed on railroad scales as it comes from the dock.

Dock: Buffalo Union Furnace Co.
Operating Company: Buffalo Union Furnace Co.
Manager: B. Marron.
Superintendent: J. J. Sammon.
Description: The dock is equipped with two Mead-Morrison unloading bridges, each equipped with one 10-ton bucket and has an unloading capacity of 1,200 tons per hour. The dock is operated both single and double shift and has a storage capacity of 300,000 tons.

Dock: Lackawanna Steel Co.
Operating Company: Lackawanna Steel Co.
General Superintendent: T. H. Mathias.
Dock Superintendent: C. Jacobson.
Description: The dock is equipped with five electric Hulett machines with 10-ton automatic buckets, and has an unloading capacity of 20,000 tons per 20-hour day. It is operated double shift, and the ore is not weighed when unloaded. The dock is equipped with three storage bridges having 7½-ton clams, and one storage bridge having a 12-ton clam. It has a storage capacity of 1,500,000 tons.

Dock: Lehigh Valley R. R. Co.
Operating Company: Lehigh Valley R. R. Co.
Local Manager and Agent: C. I. Heckman.
Division Superintendent: P. G. Flynn.
Description: The dock is equipped with six steam power Brown hoists and four steam power McMyler whirlers having 1-ton hand-filled and 3-ton automatic buckets, respectively. The shifts of hoists and whirlers are governed entirely by the amount of work on hand. They are operated single and double shift. The unloading capacity is 9,700 tons per 20-hour day and a storage capacity of 200,000 tons. The ore is weighed by the railroad company on railroad scales.

Dock: Pennsylvania R. R. Co.
Operating Company: James Thompson, Contractor.
Superintendent: R. O. Beatty.
Description: The dock is equipped with one electric Hulett and two Brown electric unloading machines having 10-ton and 5-ton automatic buckets, respectively. It is operated both single and double shift and has an unloading capacity of 14,000 tons per 20-hour day. The ore is weighed on railroad scales and the dock has a storage capacity of 200,000 tons.

Dock: Rogers-Brown Iron Co.
Operating Company: Rogers-Brown Iron Co.
Manager: John H. Kennedy.
Description: The dock is equipped with six Brown electric

unloading machines with 5-ton automatic buckets, and has an unloading capacity of approximately 15,000 tons per 20-hour day.

Dock: West Shore.
Operating Company: Ashtabula & Buffalo Dock Co.
Manager: H. S. Pickands.
Superintendent: W. E. Chilson.
Description: The dock is equipped with three Brown electric unloading machines, with 5-ton automatic buckets. It is operated two or three shifts, as required by business, and has an unloading capacity of 15,500 tons per 24-hour day, and a storage capacity of 75,000 tons. The ore is weighed by railroad scales.

Dock: Wickwire Steel Co.
Operating Company: Wickwire Steel Co.
Superintendent: J. W. Lockie.
Description: The dock is equipped with one electric Hulett with 10-ton automatic bucket and a Wellman-Seaver-Morgan fast plant with a 7½-ton bucket, and is operated double shift. It has an unloading capacity of 8,000 tons per 20-hour day, and a storage capacity of 700,000 tons. It has two storage bridges with 7½-ton clam and a 5-ton bucket.

CLEVELAND

Dock: Central Furnace.
Operating Company: American Steel & Wire Co.
Superintendent: Q. A. Gilmore.
Description: The dock is equipped with four Hoover & Mason bridges, with 7½-ton buckets, doing their own stocking, and two Hulett unloading bridges, with a 10-ton automatic bucket. It is operated single shift and has an unloading capacity of 12,000 tons per 10-hour day. The ore is weighed on railroad scales. The dock is equipped with one Hulett storage bridge with 10-ton clam and has a storage capacity of 750,000 tons.

Dock: Cleveland Furnace Co.
Operating Company: The Otis Steel Co., Cleveland Furnace Works.
Superintendent: F. W. Brown.
Description: The dock is equipped with two steam McMyler and two steam Brown rebuilt unloading machines with 2-ton and 5-ton automatic buckets, respectively. The McMyler machines are operated single shift, and have an unloading capacity of 3,000 tons per 10-hour day. The Brown machines are operated double shift, and have a capacity of 5,000 tons per 20-hour day. The ore is weighed by railroad scales. The dock is equipped with one storage bridge, with 15-ton bucket, and has a storage capacity of 500,000 tons.

Dock: Cleveland & Pittsburgh.
Operating Company: Ohio & Western Pennsylvania Dock Co.
Superintendent: C. E. Cole.
Description: The dock is equipped with four electric Huletts, with 17-ton automatic buckets, and are operated double shift, having an unloading capacity of 40,000 tons per 20-hour day. The ore is weighed by machine hopper scales. The dock is equipped with one storage bridge, with a 15-ton clam. The dock has a storage capacity of 1,000,000 tons.

Dock: Erie.
Operating Company: Erie Dock Co.
Manager: H. S. Pickands.
Superintendent: Thos. F. Zealand.
Description: The dock is equipped with four 5-ton Brown electric unloaders and one 17½-ton Hulett unloader working in one battery of five machines. This battery is operated two or three shifts as required, and has an unloading capacity of 30,000 tons per 24-hour day. Weighing at the Brown machines and Huletts by suspended hopper scales. Storage yard located at Randall equipped with 10-ton Heyl & Patterson electric ore bridges and Wellman-Seaver-Morgan car dumper. Storage capacity 1,000,000 tons. Capacity for loading into or out of storage 10,000 tons per 24-hour day.

Dock: River.
Operating Company: The River Dock Co.
Superintendent: C. E. Van Syckle.
Description: The dock is equipped with three electric Hulett unloading machines, with 10-ton automatic buckets, and is operated double shift. It has an unloading capacity of 24,000 tons per 20-hour day. The ore is weighed by railroad scales. The dock is equipped with two storage bridges, with 10-ton clams and has a storage capacity of 1,000,000 tons.

Dock: The Upson Nut Co.
Operating Company: The Upson Nut Co.
Superintendent: H. J. Allen.
Description: The dock is equipped with one Wellman-Seaver-Morgan electric bridge with 5-ton automatic bucket, and is operated double shift. It has an unloading capacity of 4,000 tons per 20-hour day, and a storage capacity of 150,000 tons. The ore is weighed by railroad scales.

CONNEAUT

Dock: Pittsburgh & Conneaut.
Operating Company: Pittsburgh & Conneaut Dock Co.
General Superintendent: R. R. Richardson.
Superintendent: Clarence Walker.
Description: Dock No. 2 is equipped with four Brown electric

machines with 5-ton automatic buckets. The capacity of these machines is 9,000 tons per 10-hour day, or 17,000 tons per 20-hour day. This dock has no storage yard.

Dock No. 4 is equipped with four steam Hulett machines with 10-ton automatic buckets and a capacity of 10,000 tons per 10-hour day or 18,000 tons per 20-hour day; three electric Hulett machines 15-ton automatic buckets and a capacity of 15,000 tons per 10-hour day or 27,000 tons per 20-hour day. This dock has a storage capacity of 1,000,000 tons and is served by two storage bridges with 7½ and 10-ton clams, respectively.

DETROIT

Dock: Detroit Iron & Steel Co.
Operating Company: Detroit Iron & Steel Co.
Superintendent: A. P. McClure.
Description: The dock is equipped with two Wellman-Seaver-Morgan ore cranes and two Brown hoisting machine cranes, with 5-ton automatic buckets. It is operated double shift, and has an unloading capacity of 5000 tons per 10-hour day. The storage capacity is 240,000 tons.

ERIE

Dock: Erie & Pittsburgh R. R.
Operating Company: Ohio & Western Pennsylvania Dock Co.
Superintendent: D. K. Smith.
Description: Dock No. 1 is equipped with 12 steam power Brown bridges with 2-ton automatic buckets. It is operated single shift and has an unloading capacity of 6,000 tons per 10-hour day. This dock has a storage capacity under machines of 120,000 tons. The trestle has a capacity of 245,000 tons. Ore is weighed by railroad scales.
Dock: Philadelphia & Erie R. R. Co.
Operating Company: James Thompson, Contractor.
Superintendent: R. M. Thompson.
Description: Dock is equipped with one electric Hulett and one Mead-Morrison combination bridge and unloader with 10-ton and 9-ton automatic bucket, respectively. It is operated both single and double shift and has an unloading capacity of 12,000 tons per 20-hour day. It has a storage capacity of 300,000 tons. Cars are spotted and moved by Baldwin Locomotive electric shunt. The ore is weighed in weighing hoppers on unloading machines.

FAIRPORT

Dock: Fairport.
Operation Company: Pennsylvania & Lake Erie Dock Co.

Manager: R. R. Richardson.
Superintendent: G. S. Meek.
Description: The dock is equipped with six Brown electric unloading machines with 5-ton automatic buckets. Three machines are operated single, and four machines double shift. The unloading capacity is 25,000 tons per 20-hour day. The ore is weighed by railroad scales.

GARY

Dock: Indiana Steel Co.
Operating Company: Indiana Steel Co.
Superintendent: W. P. Gleason.
Description: The dock is equipped with five 10-ton Hulett unloading machines and two 17-ton automatic buckets and is operated double shift. It has an unloading capacity of 35,000 tons per 20-hour day. The dock is equipped with six storage bridges, with 17-ton clams, and has a storage capacity of 3,500,000 tons.

HURON

Dock: Wheeling & Lake Erie R. R.
Operating Company: The Cleveland Stevedore Co.
Superintendent: T. R. Gilmore.
Description: Dock No. 2 is equipped with four steam Hulett and two steam and hydraulic Hulett unloading machines with 5 and 15-ton automatic buckets respectively. It is operated single shift and has an unloading capacity of 10,000 tons per 10-hour day. It is equipped with one storage bridge with 12-ton clam and has a storage capacity of 500,000 tons. The ore is weighed by railroad scales.

INDIANA HARBOR

Dock: Inland Steel Co.
Operating Company: Inland Steel Co.
President: P. D. Block.
General Superintendent: J. W. Lees.
Description: The dock is equipped with seven electric bridges with two 6-ton, three 8-ton and two 2-ton automatic buckets, and is operated double shift. It has an unloading capacity of 30,000 tons per 20-hour day. The dock has a storage capacity of 1,500,000 tons.
Dock: Mark Plant.
Operating Company: Steel & Tube Co. of America.
Superintendent: A. E. Baer.
Description: This dock is equipped with two Hoover & Mason electric unloading machines, with 5-ton buckets. The dock is operated single and double shift, having an unloading capacity of 10,000 tons in 16 hours. The dock is equipped with one Hoover & Mason storage bridge.

LORAIN

Dock: Baltimore & Ohio R. R. Co.
Operating Company: Baltimore & Ohio R. R. Co.
Terminal Agent: C. E. Pierce.
Description: The dock is equipped with three Brown electric unloading machines with 9½-ton automatic buckets, and is operated double shift. It has an unloading capacity of 20,000 tons per 20-hour day. The ore is weighed by railroad scales. The dock is equipped with one storage bridge with 10-ton clam, and has a storage capacity of 360,000 tons.

Dock: The National dock.
Operating Company: The National Tube Co., Lorain, O.
Manager: Charles Fell.
Superintendent: R. J. Aspin.
Description: The dock is equipped with four Hulett automatic electric unloaders, two machines having 10-ton buckets and two machines having 12-ton buckets. Dock is operated on double shift, and has an unloading capacity of 30,000 tons per 20-hour day. The ore is weighed by Streeter-Amet, automatic scales. The dock is also equipped with two Hoover & Mason electric ore bridges, and one Brown electric ore bridge, the Hoover & Mason bridges having 12-ton buckets and the Brown bridge having a 10-ton bucket. Capacity of each bridge, about 500 tons per hour. Storage capacity of dock, about 1,900,000 tons of ore.

MILWAUKEE

Dock: Illinois Steel Co.
Operating Company: Illinois Steel Co.
Superintendent: R. B. Charlton.
Description: The dock is equipped with four 5-ton Hoover & Mason electric unloaders with automatic buckets, and one Hoover & Mason electric bridge with 8-ton clam. The dock is operated single shift and has an unloading capacity of 3,000 tons per 12-hour day.

Dock: The Thomas Furnace Co.
Operating Company: The Thomas Furnace Co.
Superintendent: Wm. J. Price.
Description: The dock is equipped with one electric bridge with 6½-ton automatic bucket, and is operated double shift. It has an unloading capacity of 4,500 tons per 20-hour day.

PORT COLBORNE, ONTARIO

Dock: Canada Furnace Co., Ltd.
Operating Company: Canada Furnace Co., Ltd.
Manager: B. Marron, Buffalo, N. Y.
Superintendent: Chas. W. Warner, Port Colborne, Ont.
Description: The dock is equipped with two McMyler electric bridges having 6-ton automatic buckets, and has an unloading capacity of 8,000 tons per 20-hour day. It is operated both double and single shift, and all of the ore is stocked.

POINT EDWARD

Dock: Point Edward, Ont.
Operating Company: The Steel Company of Canada.
Manager: W. J. Constable.
Description: This dock is equipped with four McMyler steam unloading machines with 4-ton automatic buckets, and is operated single shift. It has an unloading capacity of 7,000 tons per 10-hour day. The ore is weighed by railroad scales. The dock has no storage capacity.

SAULT STE. MARIE

Dock: Algoma Steel Corporation, Ltd.
General Superintendent: J. D. Jones.
Description: The dock is 1,880 feet long, of which 1,731 feet is of concrete construction, and is equipped with three ore bridges of 300 feet span. Unloading capacity of bridges Nos. 1 and 2, each 60,000 tons per month, bridge No. 3, 100,000 tons. Storage capacity of dock, 1,200,000 tons. Ore handling capacity per season is 700,000 tons.

SOUTH CHICAGO

Dock: Federal Furnace Plant.
Operating Company: By-Products Coke Corporation.
General Superintendent: D. L. Ward.
Description: Dock is equipped with three Brown hoist bridge tramways, with 84 cubic foot automatic grab buckets, operating double shift, having an unloading capacity of 10,000 tons per 18-hour day. The storage capacity is 300,000 tons.
Dock: Illinois Steel Co., South Works.
Operating Company: Illinois Steel Co.
Superintendent: W. J. McGowan.
Description: The north dock is equipped with four Hoover & Mason electric machines with 8-ton automatic buckets, having a capacity of 12,000 tons in 10 hours; 11 Hoover & Mason electric machines with 5-ton automatic buckets, having a capacity of 13,000 tons in 10 hours. The dock is operated single shift. The storage capacity is 2,000,000 tons. The

dock is equipped with four storage bridges and 15-ton buckets.

Dock: Wisconsin Steel Co.
Operating Company: Wisconsin Steel Co.
Superintendent: G. E. Rose.
Description: The dock is equipped with three Brown electric unloading machines, with 5-ton automatic buckets, and is operated double shift, having an unloading capacity of 18,000 tons per 20-hour day. The dock is equipped with two storage bridges with 7-ton clams, and has a storage capacity of 450,000 tons.

Dock: Iroquois Plant.
Operating Company: Steel & Tube Co. of America.
Manager: H. C. Moore.
Superintendent: A. O. Baer.
Description: The dock is equipped with one Meade Morrison unloading machine and 10 ton buckets; two Brown electric unloading machines with 7½-ton grabs and one Hoover & Mason electric unloading machine with a 10-ton grab. The dock is operated single and double shift, having an unloading capacity of 10,000 tons in 12 hours.

TOLEDO

Dock: Baltimore & Ohio Railroad Co.
Operating Company: Baltimore & Ohio Railroad Co.
Assistant Superintendent: J. W. Kelly.
Dockmaster: C. A. Arnold.
Railroad Connections: All roads entering Toledo.
Description: The dock is equipped with two Hulett electric unloading machines with 15-ton automatic buckets and is operated triple shift, having an unloading capacity of 15,000 tons per 24-hour day. The dock is also equipped with one traveling bridge for handling ore to storage piles. The ore is weighed by machine hopper scales and by railroad scales. The storage capacity of the dock is 450,000 tons.

Dock: Toledo Furnace Co.
Operating Company: The Toledo Furnace Co.
Manager: E. B. Hull.
Description: The dock is equipped with three Hoover & Mason electric unloading machines and 5-ton automatic buckets, and is operated single and double shift, having an unloading capacity of 10,000 tons per 20-hour day. The ore is weighed by railroad scales. The dock is equipped with one storage bridge with 10-ton clam and has a storage capacity of 500,000 tons.

Dock: Toledo & Ohio Central R. R. Co.
Operating Company: Toledo & Ohio Central R. R. Co.
Superintendent: C. A. Hoyt.
Description: The dock is equipped with three Brown electric unloading machines with 5-ton automatic buckets, and is operated single shift, and double shift when necessary to handle the tonnage, having an unloading capacity of 5,000 tons per 10-hour day. The ore is weighed by railroad scales. The storage capacity is 70,000 tons.

PARRY SOUND

Dock: Parry Sound.
Operating Company: At present the plant is idle.
Description: The dock is equipped with one unloading machine, and is operated double shift. It has an unloading capacity of 500 tons per 10-hour day. The storage capacity is 30,000 tons.

DESERONTO

Dock: Standard Iron Co., Ltd.'s Dock.
Operating Company: Standard Iron Co., Ltd.
Superintendent: O. O. Laudig.
Description: The dock is equipped with one unloading machine and is operated double shift. It has an unloading capacity of 400 tons per 10-hour day. The storage capacity is 50,000 tons.

MIDLAND

Dock: Canada Iron Foundries, Ltd.
Operating Company: Canada Iron Foundries, Ltd.
Description: The dock is equipped with two steam McMyler machines with 5-ton automatic buckets, and has an unloading capacity of 1,200 tons per 10-hour day.

Chapter XII

LOCATION AND DESCRIPTION OF MINES

VERMILION RANGE

CHANDLER MINE

Location: St. Louis county, Minn., Section 28, Township 63 N, Range 12W.

Description: First opened up in 1888. The ore is a hard, red bessemer hematite. The mine is worked by the underground method, the greatest vertical depth being 920 feet. The ore is shipped via the Duluth & Iron Range railway, to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Chandler Mining Co., Virginia, Minn.

Manager: Frank A. Kent.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1888—454,612	tons	1899—808,359	tons	1910—	
1889—306,220	tons	1900—644,801	tons	1911— 50,206	tons
1890—336.002	tons	1901—627,379	tons	1912— 73,570	tons
1891—373,969	tons	1902—645,786	tons	1913— 51,403	tons
1892—651,655	tons	1903—460,548	tons	1914—	
1893—435,930	tons	1904—422,162	tons	1915— 24,741	tons
1894—558,050	tons	1905—365,739	tons	1916—188,800	tons
1895—605,024	tons	1906—318,990	tons	1917— 80,817	tons
1896—471,545	tons	1907—245,684	tons	1918—171,594	tons
1897—438,365	tons	1908— 50,639	tons	1919— 48,274	tons
1898—715,919	tons	1909—			

Total, tons 10,226,583

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.
60.00	.043	9.25	.13	3.17

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
5.00	57.00	.041	8.79

PIONEER MINE

Location: St. Louis county, Minn., Section 27, Township 63, Range 12.

Description: First opened up in 1889. The mine ships two grades of ore: PIONEER, a hard, red-brown, bessemer hematite; and FRONTIER, a hard, red-brown, nonbessemer hematite. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 1,466

feet. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ely, Minn.

General Manager: J. H. McLean.

District Manager: W. J. West, Virginia, Minn.

Yearly Shipments:

1889— 3,144 tons	1900—450,794 tons	1911—400,919 tons
1890— 12,012 tons	1901—678,100 tons	1912—647,237 tons
1891— 3,079 tons	1902—673,836 tons	1913—520,124 tons
1892— 2,651 tons	1903—596,735 tons	1914—282,559 tons
1893—	1904—505,432 tons	1915—453,099 tons
1894—	1905—653,682 tons	1916—507,086 tons
1895— 40,054 tons	1906—766,853 tons	1917—532,497 tons
1896—149,073 tons	1907—830,700 tons	1918—260,516 tons
1897—204,103 tons	1908—477,506 tons	1919—376,828 tons
1898—123,183 tons	1909—477,226 tons	
1899—339,897 tons	1910—526,435 tons	

Total tons 11,318,597

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Pioneer:

Iron	Phos.	Silica	Mang.
62.65	.039	5.92	.120

The ore in its natural state is as follows:

Pioneer:

Moist.	Iron	Phos.	Silica
6.68	58.46	.036	5.52

SAVOY MINE

Location: St. Louis county, Minn., Section 26, Township 63. Range 12.

Description: First opened up in 1889, but the mine is now exhausted.

Yearly Shipments:

1899— 81,022 tons	1905— 91,775 tons	1911— 87,964 tons
1900—170,446 tons	1906—106,933 tons	1912— 90,528 tons
1901—212,008 tons	1907— 43,320 tons	1913— 74,971 tons
1902—243,937 tons	1908— 82,521 tons	1914— 74,541 tons
1903—169,616 tons	1909— 83,167 tons	1915— 76,672 tons
1904— 74,866 tons	1910— 59,875 tons	1916— 38,067 tons

Total, tons 1,862,229

SECTION 30 MINE

Location: Lake county, Minn., Section 30, Township 63, Range 11 W.

Description: First opened up in 1909. The ore is a hard, blue bessemer and nonbessemer hematite and is crushed. The mine is worked by the open-pit and sub-stoping methods, the

greatest vertical depth being 650 feet. The ore is shipped via the D. & I. R. railway to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Section Thirty Mining Co., Sellwood Bldg., Duluth, Minn.

Manager: Geo. A. St. Clair.

Superintendent: H. G. St. Clair.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1910— 51,650 tons	1914— 85,943 tons	1918—125,423 tons
1911— 34,298 tons	1915—177,143 tons	1919— 78,166 tons
1912—157,344 tons	1916—226.089 tons	
1913—136,359 tons	1917—223,123 tons	

Total, tons 1,295,538

SIBLEY MINE

Location: St. Louis county, Minn., Sections 26 and 27, Township 63, Range 12.

Description: First opened up in 1899. The ore is hard, red-brown bessemer hematite. The mine is worked by the underground methods, the greatest vertical depth being 1285 feet. The ore is shipped via the D. & I. R. railway to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ely, Minn.

General Manager: J. H. McLean:

District Manager: W. J. West, Virginia, Minn.

Yearly Shipments:

1899— 5,169 tons	1906—271,496 tons	1913—249,255 tons
1900— 4,670 tons	1907—226,835 tons	1914— 74,868 tons
1901—	1908—127,544 tons	1915—129,565 tons
1902— 78,304 tons	1909—151,009 tons	1916—237,258 tons
1903—113,595 tons	1910—206,386 tons	1917—198,378 tons
1904—122,783 tons	1911— 1,899 tons	1918—149,125 tons
1905—251,170 tons	1912—309,076 tons	1919—154,614 tons

Total, tons 3,062,999

SOUDAN MINE

Location: St. Louis county, Minn., Sections 27, 28, 32, 33, and 34, Township 62, Range 15.

Description: First opened up in 1884. The ore, VERMILION, LUMP, is a hard steel-blue nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 2707 feet. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Soudan, Minn.
General Manager: J. H. McLean.
District Manager: W. J. West, Virginia, Minn.
Yearly Shipments:

1884— 62,124 tons	1896—448,707 tons	1908— 53,070 tons
1885—225,484 tons	1897—592,196 tons	1909— 74,862 tons
1886—304,396 tons	1898—426,040 tons	1910— 75,511 tons
1887—394,252 tons	1899—457,732 tons	1911— 65,349 tons
1888—457,341 tons	1900—325,020 tons	1912— 88,714 tons
1889—535,318 tons	1901—208,284 tons	1913—100,885 tons
1890—532,000 tons	1902—275,168 tons	1914— 74,972 tons
1891—517,570 tons	1903—175,114 tons	1915— 77,636 tons
1892—498,353 tons	1904— 70,713 tons	1916—142,688 tons
1893—370,303 tons	1905—205,002 tons	1917—150,668 tons
1894—390,463 tons	1906—146,503 tons	1918—124,873 tons
1895—432,760 tons	1907—102,977 tons	1919—115,330 tons

Total, tons 9,298,478

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
63.49	.161	6.40	.093

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
.95	62.89	.159	6.34

SOUTH CHANDLER MINE

Location: St. Louis county, Minn., SE¼ of SE¼ of Section 28, Township 63, Range 12.

Description: First opened up in 1888, abandoned 1905, and reopened in 1913. The ore, PATTISON, is a hard, red, bessemer hematite, and is crushed. The mine is worked by the slicing system, the greatest vertical depth being 800 feet. The ore is shipped via the D. & I. R. railway to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: B. M. Pattison, Lessee, Sellwood Bldg., Duluth, Minn.
Manager: Byron M. Pattison.
Superintendent: W. J. Mudge.
Sales Agents: Pickands, Mather & Co., Cleveland, O.
Yearly Shipments:

1915— 79,915 tons	1917—122,020 tons	1919— 30,534 tons
1916—120,581 tons	1918—111,780 tons	

Total, tons 464,830

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.
58.00	.045	12.00	.21	4.00

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
6.50	54.28	.042	11.22

SULLIVAN MINE

Location: Lake county, Minn., Section 30, Township 63, Range 11.

Description: First opened up in 1912, but is now idle.

ZENITH MINE

Location: St. Louis county, Minn., Section 27, Township 63, Range 12.

Description: First opened up in 1892 by the Oliver Iron Mining Co. Lease was taken over July 1, 1919 by the Zenith Iron Mining Co. The ore, PIONEER, is a hard red-brown bessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 1102 feet. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Zenith Iron Mining Co., 811 Sellwood, Bldg., Duluth, Minn.

General Manager: R. M. Sellwood.

Superintendent: Kenneth Duncan.

Sales Agents: Pickands, Mather & Co.

Yearly Shipments:

1892—	14,991	tons	1902—	167,205	tons	1912—	478,682	tons
1893—	14,388	tons	1903—	161,091	tons	1913—	433,603	tons
1894—			1904—	86,557	tons	1914—	424,110	tons
1895—			1905—	109,818	tons	1915—	714,852	tons
1896—	18,765	tons	1906—	181,580	tons	1916—	482,783	tons
1897—	40,817	tons	1907—	235,751	tons	1917—	382,666	tons
1898—			1908—	50,264	tons	1918—	243,093	tons
1899—	79,323	tons	1909—	321,951	tons	1919—	124,721	tons
1900—	60,089	tons	1910—	283,320	tons			
1901—	60,082	tons	1911—	448,295	tons			

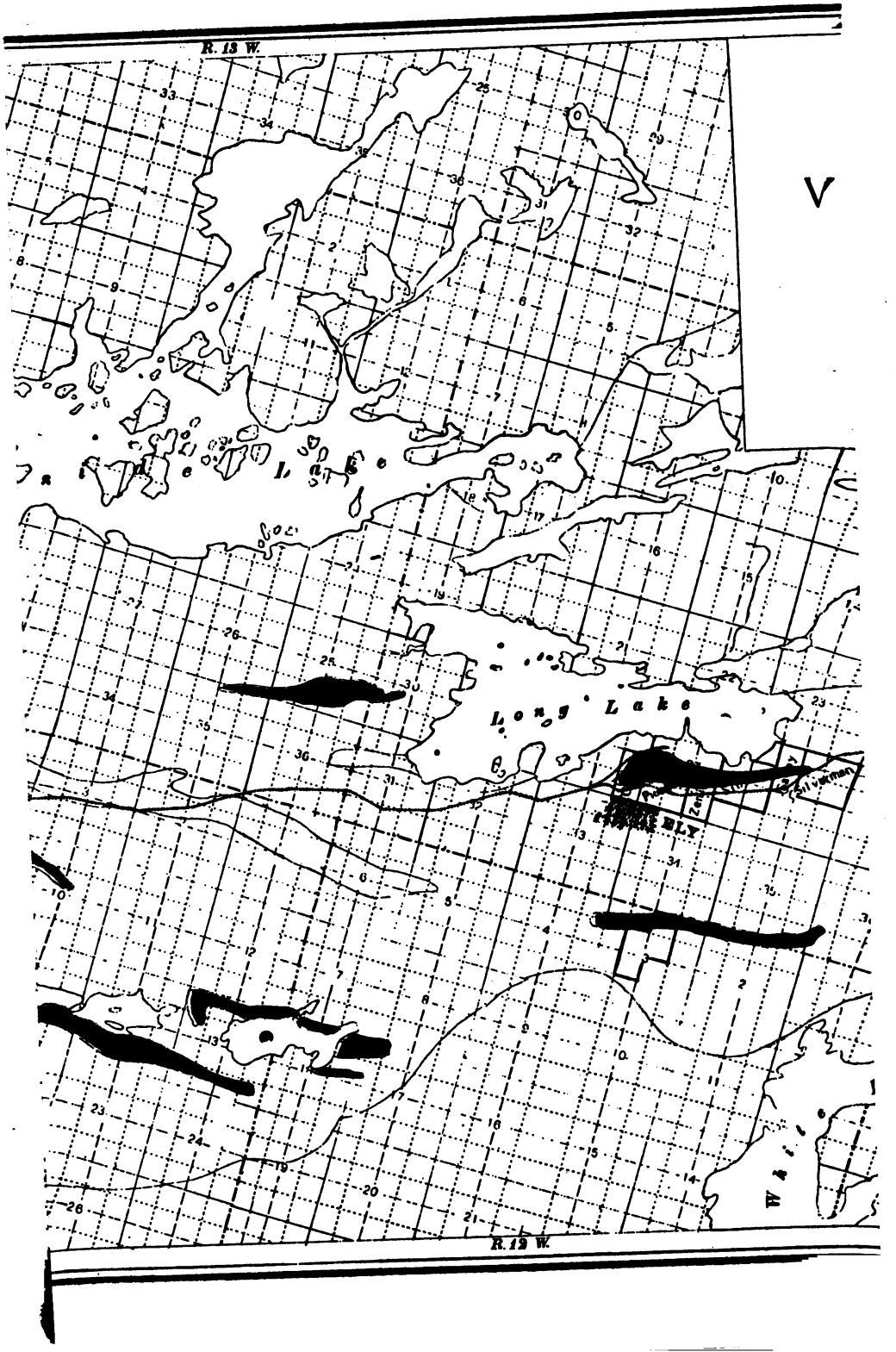
Total, tons 5,618,797

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
62.65	.039	5.92	.120

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
6.68	58.46	.036	5.52


R. 13 W.
V
Long Lake
Long Lake
R. 12 W.

MESABI RANGE

AAD MINE (Formerly Rutland)

Location: St. Louis county, Minn., Section 31, Township 58, Range 17.

Description: First opened up in 1918. The ore, AAD, is a soft, red nonbessemer hematite. The mine is worked by the underground top-slicing system. The ore is shipped via the D. & I. R. railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Rutland Mining Co., Eveleth, Minn.

Manager: M. S. Kingston.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1917— 58,881 tons	1918— 23,278 tons	1919— 38,030 tons

Total, tons 112,189

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.
56.50	.078	7.45	1.40	1.80

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
13.00	49.16	.068	6.48

ADAMS MINE

Location: St. Louis county, Minn., Section 31, Township 58, Range 17.

Description: First opened up in 1895. This mine ships three grades of ore: GROUP 1, a soft, brown bessemer hematite, GROUP 4, a soft, tan nonbessemer hematite, and GROUP 5 a soft grayish-black bessemer hematite. The mine is worked by the open-pit system. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Eveleth, Minn.

General Manager: J. H. McLean.

District Manager: W. J. West, Virginia, Minn.

Yearly Shipments:

1895— 59,141 tons	1904— 940,105 tons	1913—1,580,196 tons
1896— 234,562 tons	1905—1,140,984 tons	1914— 286,522 tons
1897— 170,738 tons	1906—1,238,350 tons	1915— 902,372 tons
1898— 390,860 tons	1907—1,136,513 tons	1916— 961,500 tons
1899— 720,474 tons	1908— 765,592 tons	1917—1,546,546 tons
1900— 777,346 tons	1909—1,829,372 tons	1918—1,084,985 tons
1901— 829,118 tons	1910—1,258,295 tons	1919— 699,316 tons
1902—1,242,923 tons	1911— 411,268 tons	
1903—1,109,750 tons	1912— 993,523 tons	

Total, tons 22,310,351

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Group 1:

Iron	Phos.	Silica	Mang.
60.09	.041	6.51	.60

Group 4:

56.04	.070	8.26	1.12

Group 5:

55.45	.045	13.68	.47

The ore in its natural state is as follows:

Group 1:

Moist.	Iron	Phos.	Silica
12.24	52.74	.036	5.71

Group 4:

14.60	47.86	.060	7.05

Group 5:

10.73	49.50	.040	12.22

ADRIATIC MINE

Location: St. Louis county, Minn., Section 30, Township 59, Range 14.

Description: First opened up in 1906. The ore is a soft, red, nonbessemer hematite. The mine is worked by the underground slicing system, the greatest vertical depth being 180 feet. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Adriatic Mining Co., Cleveland, O.

Manager: R. M. Sellwood.

Superintendent: Wm. Mudge.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1906— 3,294	tons	1911— 73,280	tons	1916—220,818	tons
1907— 70,187	tons	1912—102,478	tons	1917— 90,283	tons
1908—108,129	tons	1913—110,534	tons	1918— 37,189	tons
1909—107,317	tons	1914— 74,911	tons	1919—	None
1910—135,685	tons	1915— 33,625	tons		

Total, tons 1,167,730

AGNEW MINE

Location: St. Louis county, Minn., Section 11, Township 57 N, Range 21 W.

Description: First opened up in 1902. The ore is a soft, red, bessemer hematite and is crushed. The mine is worked by the open-pit system, the greatest vertical depth being 230 feet. The ore is shipped via the Great Northern railroad to

Superior, Wis., and from there by boat to the lower lake ports.

Operating Company: The Wisconsin Steel Co., Nashwauk, Minn.

Superintendent: B. W. Batchelder.

Sales Agents: Wisconsin Steel Co., Harvester Bldg., Chicago, Ill.

Yearly Shipments:

1902— 45,582 tons	1908—164,486 tons	1914—108,558 tons
1903—108,847 tons	1909—151,536 tons	1915—
1904— 96,433 tons	1910—152,834 tons	1916—102,150 tons
1905— 44,651 tons	1911—153,425 tons	1917—108,908 tons
1906—163,260 tons	1912—101,498 tons	1918— 96,940 tons
1907—149,084 tons	1913—101,549 tons	1919— 44,673 tons

Total, tons 1,894,414

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
51.59	.062	16.26	.200

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
5.97	48.51	.058	15.29

AJAX MINE (Formerly Kanawha Mine)

Location: St. Louis county, Minn., Section 1, Township 58, Range 16.

Description: First opened up in 1889, but is now idle.

Yearly Shipments:

1899— 14,963 tons	1902— 24,829 tons	1905— 28,439 tons
1900— 64,218 tons	1903— 23,932 tons	1906— 9,057 tons
1901— 41,300 tons	1904— 912 tons	1918—493,985 tons

Total, tons 701,635

ALBANY MINE

Location: St. Louis county, Minn., Section 32, Township 58, Range 20.

Description: First opened up in 1903. This mine ships three ores: ALBANY, a soft, yellow nonbessemer hematite, CRETE, a soft, red bessemer hematite, and ALBANY REX, a soft, dark red nonbessemer hematite. The mine is worked by the milling and underground slicing systems, the greatest vertical depth being 260 feet. The ore is shipped via the Great Northern and the D., M. & N. railways to Duluth and Superior, and thence by boat to lower lake ports.

Operating Company: Crete Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: Robert Murray.
Sales Agents: Pickands, Mather & Co., Cleveland, O.
Yearly Shipments:

1903—109,608 tons	1909—368,057 tons	1915—317,030 tons
1904—153,433 tons	1910—267,583 tons	1916—468,291 tons
1905—241,186 tons	1911—132,572 tons	1917—455,182 tons
1906—356,371 tons	1912—244,669 tons	1918—493,985 tons
1907—437,521 tons	1913—345,162 tons	1919—148,698 tons
1908— 64,860 tons	1914—227,766 tons	

Total, tons 4,831,974

Analysis: See analysis of ALBANY and CRETE.

ALEXANDRIA MINE

Location: St. Louis county, Minn., SE¼-SW¼ and SW¼-SE¼, Section 29, Township 59, Range 20.

Description: First opened up in 1915. The ore is a soft, brown, nonbessemer hematite. The mine is worked by the underground mining methods, the greatest vertical depth being 105 feet. The ore is shipped via the Great Northern railroad to Allouez docks, at Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.
Manager: E. E. Hunner.
Superintendent: F. H. Cohoe.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

1917—139,980 tons	1918—202,586 tons	1919—133,278 tons

Total, tons 475,844

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.70	.090	6.60	1.22	1.80	.19	.15	.016	9.60

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
12.86	48.54	.078	5.75

ALEXANDRIA SNYDER

Location: St. Louis county, Minn., SW¼ of SW¼ of Section 29, Township 58, Range 20.

Description: First opened up in 1917. The ore is a soft brown nonbessemer hematite. The mine is worked by the underground method. The ore is hoisted through Alexandria shaft 105 feet to main level. The ore is shipped via the Great Northern railway to Allouez docks, Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Hanna Ore Mining Co., Virginia, Minn.
Manager: E. E. Hunner.
Superintendent: F. H. Cohoe.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

1917—	525 tons	1918—	3,825 tons	1919—	14,083 tons

Total, tons 18,433

Analysis: See ALEXANDRIA.

ARCTURUS MINE

Location: Itasca county, Minn., Sections 13 and 24, Township 56, Range 24.

Description: First opened up in 1917. This mine ships five grades of ore: GROUPS 2, 5 and 10, soft, brown bessemer hematites, and GROUPS 3 and 7, soft, brown nonbessemer hematites. The mine is worked by the surface method, the greatest vertical depth being 111 feet. The ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Marble, Minn.
General Manager: J. H. McLean.
District Manager: M. H. Godfrey, Hibbing, Minn.
Yearly Shipments:

1917—	314,049 tons	1918—	295,546 tons	1919—	543,967 tons

Total, tons 1,153,562

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Group 2:

Iron	Phos.	Silica	Mang.
61.67	.049	4.90	.57

Group 3:

58.96	.082	6.09	.75

Group 5:

55.45	.045	13.68	.47

Group 7:

55.34	.093	12.26	.58

Group 10:

52.45	.042	18.29	.46

The ore in its natural state is as follows:

Group 2:

Moist.	Iron	Phos.	Silica
11.51	54.57	.043	4.34

Group 3:

13.37	51.08	.070	5.28

Group 5:

10.73	49.50	.040	12.21

Group 10:

10.66	46.86	.038	16.34

AUBURN MINE

Location: St. Louis county, Minn., Section 20, Township 58, Range 17.

Description: First opened up in 1894. The mine is now inactive.

Yearly Shipments:

1894—108,210 tons	1897—175,263 tons	1900—263,692 tons
1895—376,970 tons	1898—235,630 tons	1901—427,510 tons
1896—131,478 tons	1899—385,992 tons	1902— 38,283 tons

Total, tons 2,143,028

BANGOR MINE

Location: St. Louis county, Minn., Sections 1 and 6, Township 58, Range 15 and 16.

Description: First opened up in 1910, but is now idle.

Operating Company: Bangor Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. C. David.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1910— 17,673 tons	1914— 91,189 tons	1918—122,621 tons
1911—119,508 tons	1915—294,346 tons	1919—
1912—130,997 tons	1916—223,576 tons	
1913—119,705 tons	1917—155,053 tons	

Total, tons 1,274,668

BELGRADE MINE (Formerly Kellogg)

Location: St. Louis county, Minn., Section 9, Township 58, Range 16.

Description: First opened up in 1908. This mine ships BELGRADE, a soft, red, bessemer hematite. The mine is worked by the underground slicing system, the greatest vertical depth being 260 feet. The ore is shipped via the D. & I. R. railway to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: The Balkan Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. C. David.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1908— 31,331 tons	1912—127,412 tons	1916—180,532 tons
1909—165,458 tons	1913—	1917—218,596 tons
1910—142,906 tons	1914—155,012 tons	1918—197,366 tons
1911—113,038 tons	1915—241,525 tons	1919—112,942 tons

Total, tons 1,686,118

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.
58.50	.037	10.00	.69	1.30

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
9.00	53.24	.034	9.10

BENNETT MINE

Location: Itasca county, Minn., Section 24, Township 57, Range 22.

Description: First opened up in 1912. This mine ships three grades of ore: MERIDEN, a soft, red bessemer hematite; BENNETT, a soft, red nonbessemer hematite, and BENNETT REX, a soft, red high-manganese nonbessemer hematite. The mine is worked by the open-pit and underground system, the greatest vertical depth being 150 feet. The ore is shipped via the Great Northern railroad to the docks at Allouez, Wis., and thence by boat to lower lake ports.

Operating Company: Bennett Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: F. P. Botsford.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1913— 88,931 tons	1916—672,572 tons	1919—552,970 tons
1914— 25,868 tons	1917—783,826 tons	
1915— 50,475 tons	1918—872,421 tons	

Total, tons 3,047,063

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Meriden:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.35	.047	11.13	.59	1.17	.10	.05	.012	4.63

The ore in its natural state is as follows:

Meriden:

Moist.	Iron	Phos.	Silica
9.60	51.84	.042	10.06

BESSEMER MINE

Location: St. Louis county, Minn., Section 9, Township 58, Range 17.

Description: First opened up in 1904, but is now idle.

Yearly Shipments:

1904— 86,303 tons	1908—120,350 tons	1912—136,010 tons
1905—112,630 tons	1909—227,767 tons	1913—
1906—131,791 tons	1910—117,173 tons	1914—
1907— 78,012 tons	1911—179,051 tons	1915— 49,459 tons

Total, tons 1,238,546

BILLINGS MINE

Location: St. Louis county, Minn., S.½-N.E.¼, Section 23, Township 58, Range 20.

Description: First opened up in 1919. The ore, SEVERN, is a soft, nonbessemer hematite. The mine is worked by the

underground method. The ore is shipped via the Great Northern railroad to Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: The Stambaugh Iron Co., Chisholm, Minn.

Manager: J. S. Lutes.

Superintendent: C. H. Claypool.

Yearly Shipments:

1919— 23,918 tons

Total, tons 23,918

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.48	.073	9.37	1.74	2.80	.62	.36	.007	2.33

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
13.03	49.99	.063	8.15

BINGHAM MINE

Location: Itasca county, Minn., Section 21, Township 56. Range 24.

Description: Mine not yet opened.

Operating Company: The Mesaba-Cliffs Iron Mining Co., Taconite, Minn.

Manager: M. M. Duncan.

Superintendent: M. H. Barber.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

BIWABIK MINE

Location: St. Louis county, Minn., Sections 2 and 3, Township 58, range 16.

Description: First opened up in 1893. This mine ships two ores, BIWABIK, a bessemer hematite, and SHILLING, a non-bessemer hematite. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and from there by boat to the lower lake ports.

Sales Agents: The Tod-Stambaugh Co., Cleveland, O.

Yearly Shipments:

1893—	151,500 tons	1902—	623,127 tons	1911—	211,071 tons
1894—	90,048 tons	1903—	807,511 tons	1912—	312,378 tons
1895—	247,069 tons	1904—	647,614 tons	1913—	300,924 tons
1896—	242,565 tons	1905—	1,092,987 tons	1914—	255,255 tons
1897—	427,464 tons	1906—	807,374 tons	1915—	385,389 tons
1898—	383,180 tons	1907—	803,750 tons	1916—	428,944 tons
1899—	553,836 tons	1908—	365,781 tons	1917—	342,570 tons
1900—	924,868 tons	1909—	542,821 tons	1918—	496,061 tons
1901—	410,074 tons	1910—	544,353 tons	1919—	395,109 tons

Total, tons 12,793,623

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Shilling:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.30	.080	6.40	1.16	2.67	.15	.07	.011	6.81

Biwabik:

61.61	.046	5.10	.56	1.67	.20	.24	.025	4.20

The ore in its natural state is as follows:

Shilling:

Moist.	Iron	Phos.	Silica
12.20	50.31	.070	5.62

Biwabik:

10.58	55.09	.041	4.56

BOEING MINE

Location: St. Louis county, Minn., Section 6, Township 57, Range 20.

Description: First opened up in 1919. The product is a hematite ore. The mine is worked by the open-pit method and the ore is shipped via the Great Northern railroad to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: The Mesaba-Cliffs Iron Mining Co., Hibbing, Minn.

Manager: M. M. Duncan.

Superintendent: M. H. Barber.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

BRAY MINE

Location: Itasca county, Minn., Section 23, Township 57, Range 22.

Description: First opened up in 1909. The ore is a soft, red, nonbessemer hematite. The mine is worked by the slicing and milling systems, the greatest vertical depth being 124 feet. The ore is shipped via the Great Northern Railroad to the G. N. docks at Allouez Bay, Wis., and thence by boat to the lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, O.

Manager: F. J. Webb.

Superintendent: D. T. Caine.

Sales Agents: Oglebay, Norton & Co., Cleveland, O.

Yearly Shipments:

1909— 65,514 tons	1913—102,439 tons	1917— 56,011 tons
1910— 57,789 tons	1914—	1918—137,834 tons
1911—	1915—	1919— 40,095 tons
1912—164,732 tons	1916—	

Total, tons 624,414

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.98	.074	10.60	1.42	2.76	.28	.29	.014	3.64

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
14.24	48.01	.063	9.09

BRUNT MINE

Location: St. Louis county, Minn., Section 10, Township 58, Range 18.

Description: First opened up in 1906. The ore is a soft, red nonbessemer siliceous hematite. Open-pit method of mining is used. The greatest vertical depth is 110 feet. The ore is shipped via the D., M. & N. railway to Duluth and from there by boat to lower lake ports.

Operating Company: Pittsburgh Iron Ore Co., Hibbing, Minn.

Manager: Earl E. Hunner.

General Superintendent: F. H. Cohoe.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1906— 75,401 tons	1911—136,531 tons	1916—162,290 tons
1907—178,935 tons	1912—215,585 tons	1917—112,289 tons
1908— 636 tons	1913—202,969 tons	1918—257,597 tons
1909— 14,212 tons	1914—	1919— 7,531 tons
1910—110,630 tons	1915— 11,805 tons	

Total, tons 1,486,411

Analysis: See HANNA GRADE.

BURNS MINE

Location: St. Louis county, Minn., Section 4, Township 57, Range 17.

Description: First opened up in 1918. This mine ships two grades of ore: BURNS BESSEMER, a soft, red bessemer hematite, and BURNS, a soft, red nonbessemer hematite. The mine is worked by the underground top-slicing system, the greatest vertical depth being 90 feet. The ore is shipped via the D. & I. R. railway to Two Harbors, and thence by boat to the lower lake ports.

Operating Company: Sachem Iron Co., Duluth, Minn.

Manager: W. W. Bowe.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1918— 81,364 tons 1919— 53,835 tons

Total, tons 135,199

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Burns:

Iron	Phos.	Silica	Mang.	Alum.
57.40	.064	6.70	1.24	1.52

The ore in its natural state is as follows:

Burns:

Moist.	Iron	Phos.	Silica
14.25	49.22	.055	5.75

BURT-POOL-DAY MINE

Location: St. Louis county, Minn., Sections 31 and 36, Township 58, Range 20 and 21.

Description: First opened up in 1895. This mine ships six grades of ore: GROUP 2, soft, black bessemer hematite, GROUP 5 and GROUP 10, a soft yellowish-red bessemer hematite, GROUP 7, a soft yellowish-red nonbessemer hematite, GROUPS 3 and 9, a soft brownish-yellow nonbessemer hematite. The mine is worked by the open-pit system. The ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean.

District Manager: M. H. Godfrey, Hibbing, Minn.

Yearly Shipments:

1895—	58,123	tons	1904—	1,155,643	tons	1913—	622,951	tons
1896—	35,677	tons	1905—	1,860,452	tons	1914—	213,433	tons
1897—	71,772	tons	1906—	1,376,875	tons	1915—	1,043,607	tons
1898—	16,102	tons	1907—	1,501,272	tons	1916—	1,060.487	tons
1899—	20,264	tons	1908—	1,460,998	tons	1917—	692,017	tons
1900—	111,982	tons	1909—	1,660,101	tons	1918—	747,968	tons
1901—	118,176	tons	1910—	1,032,815	tons	1919—	683,205	tons
1902—	100,330	tons	1911—	56,506	tons			
1903—	646,935	tons	1912—					

Total, tons 16,347,691

Analysis: See analyses of groups 2, 3, 5, 7, 9 and 10.

CANISTEO MINE

Location: Itasca county, Minn., Sections 29, 30, 31 and 32, Township 56, Range 24.

Description: First opened up in 1907. This mine ships seven grades of ore: GROUPS 2, 5 and 10, soft, brown bessemer hematites, GROUPS 3, 4, 6 and 7, soft, brown nonbessemer hematites. The mine is worked by the open-pit system. The

ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Coleraine, Minn.
General Manager: J. H. McLean.
District Manager: M. H. Godfrey, Hibbing, Minn.
Yearly Shipments:

1907— 5,454 tons	1912—2,099,880 tons	1917—1,643,226 tons
1908— 2,760 tons	1913—1,099,727 tons	1918—1,426,399 tons
1909— 85,505 tons	1914—1,051,895 tons	1919—1,255,742 tons
1910—1,105,160 tons	1915—1,622,182 tons	
1911—1,340,378 tons	1916—1,943,745 tons	

Total, tons 14,682,053

Analysis: See analyses of GROUPS 2, 3, 4, 6, 7 and 10.

CANTON MINE

Location: St. Louis county, Minn., Section 3, Township 58, Range 16.

Description: First opened up in 1893. The ore is a bessemer hematite. The mine was operated by the Oliver Iron Mining Co., but is now inactive.

Yearly Shipments:

1893— 24,416 tons	1896— 16,261 tons	1899— 99,498 tons
1894—213,853 tons	1897—	
1895—359,020 tons	1898—	

Total, tons 713,048

CARSON LAKE

Location: St. Louis county, Minn., Section 10, Township 57, Range 21.

Description: First opened up in 1919. This mine ships three grades of ore: GROUPS 3 and 9, soft, red-brown bessemer hematites; GROUP 7, soft, yellow-red, nonbessemer hematites. The mine is worked by the underground system, the greatest vertical depth being 166 feet. The ore is shipped via the D. M. & N. railroad to Duluth, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.
General Manager: J. H. McLean.
District Manager: M. H. Godfrey, Hibbing, Minn.
Yearly Shipments: 5,025 tons.
Analysis: See analyses of GROUPS 3, 7 and 9.

CAVOUR MINE

Location: St. Louis county, Minn., Section, 15, Township 58, Range 19.

Description: The mine was first opened up in 1910, but is now worked out.

Yearly Shipments:

1911— 1,104 tons	1914— 16,837 tons	1917— 5,043 tons
1912— 47,919 tons	1915—	1918—
1913—118,404 tons	1916—134,632 tons	1919—

Total, tons 323,939

CHESTER MINE

Location: St. Louis county, Minn., Section 27, Township 58, Range 20.

Description: First opened up in 1915. This mine ships seven grades of ore: GROUPS 5 and 10, soft, light-yellow bessemer hematites, GROUPS 3, 7 and 9, soft light-yellow nonbessemer hematites and GROUPS 2 and 4. The mine is worked by the underground system, the greatest vertical depth being 251 feet. The ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn.

General Manager: J. H. McLean.

District Manager: M. H. Godfrey, Hibbing, Minn.

Yearly Shipments:

1915— 6,150 tons	1917—354,824 tons	1919—268,260 tons
1916— 73,401 tons	1918—346,546 tons	

Total, tons 1,049,181

Analysis: See analyses of GROUPS 2, 3, 4, 5, 7, 9 and 10.

CHISHOLM MINE

Location: St. Louis county, Minn., Section 28, Township 58, Range 20.

Description: First opened up in 1901. This mine ships five grades of ore: GROUP 2, a soft, brown bessemer hematite; GROUPS 3, 5, 7 and 9, soft, reddish brown, nonbessemer hematites. The mine is worked by the underground system, the greatest vertical depth being 152 feet. The ore is shipped via the D. M. & N. and the G. N. railroads to Duluth, Minn., and Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn.

General Manager: J. H. McLean.

District Manager: M. H. Godfrey, Hibbing, Minn.

Yearly Shipments:

1901— 34,563 tons	1908—228,386 tons	1915—468,680 tons
1902—200,629 tons	1909—314,597 tons	1916—263,820 tons
1903—168,831 tons	1910—634,236 tons	1917—382,184 tons
1904—130,732 tons	1911—721,784 tons	1918—322,528 tons
1905—231,296 tons	1912—695,859 tons	1919—295,538 tons
1906—379,156 tons	1913—641,788 tons	
1907—258,793 tons	1914—399,500 tons	

Total, tons 6,772,910

Analysis: See analyses of GROUPS 2, 3, 5, 7, and 9.

CLARK MINE

Location: St. Louis county, Minn., Section 28, Township 58, Range 20.

Description: First opened up in 1900. This mine ships five grades of ore: GROUP 2, a soft, yellowish-brown bessemer

hematite; GROUPS 3, 4, 7 and 9, soft, yellow nonbessemer hematites. The mine is worked by the underground system, the greatest vertical depth being 201 feet. The ore is shipped via the D., M. & N. and the G. N. railroads to Duluth, Minn., and Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn.
General Manager: J. H. McLean.
District Manager: M. H. Godfrey, Hibbing, Minn.
Yearly Shipments:

1900— 63,071 tons	1907—319,983 tons	1914—392,530 tons
1901—199,566 tons	1908—334,594 tons	1915—439,461 tons
1902—350,799 tons	1909—484,512 tons	1916—251,226 tons
1903—300,492 tons	1910—529,222 tons	1917—266,710 tons
1904—256,873 tons	1911—500,999 tons	1918—198,265 tons
1905—358,091 tons	1912—500,768 tons	1919—162,079 tons
1906—274,394 tons	1913—402,893 tons	

Total, tons 6,586,528

Analysis: See analyses of GROUPS 2, 3, 4, 7 and 9.

COLUMBIA MINE

Location: St. Louis county, Minn., Section 8, Township 58, Range 17.
Description: First opened up in 1901, but is now idle.
Operating Company: Inter-State Iron Co., Jones & Laughlin Bldg., Pittsburgh, Pa.
General Superintendent: Mark Elliott.
Yearly Shipments:

1901— 15,627 tons	1905— 1,360 tons

Total, tons 16,987

COMMODORE MINE

Location: St. Louis county, Minn., Section 9, Township 58, Range 17.
Description: First opened up in 1893. Two ores are shipped from this mine: ADMIRAL, a soft, blue bessemer hematite, and COMMODORE, a soft, blue nonbessemer hematite. The open-pit system of mining is used. The ore is shipped via the Great Northern railroad to Allouez, Wis., and from there by boat to the lower lake ports.
Sales Agents: The McKinney Steel Co.
Yearly Shipments:

1893— 65,137 tons	1902— 65,833 tons	1911—294,787 tons
1894— 7,213 tons	1903— 20,436 tons	1912—567,855 tons
1895—	1904— 249 tons	1913—484,188 tons
1896— 22,063 tons	1905—146,901 tons	1914—372,796 tons
1897— 60,798 tons	1906—263,401 tons	1915—561,438 tons
1898— 80,494 tons	1907—319,983 tons	1916—579,285 tons
1899—152,947 tons	1908—116,069 tons	1917—405,827 tons
1900—278,416 tons	1909—409,148 tons	1918—244,247 tons
1901— 35,546 tons	1910—341,548 tons	1919—359,086 tons

Total, tons 6,421,911

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Admiral:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
61.00	.040	6.90	.55	.70	.35	.57	.009	3.50

Commodore:

58.02	.055	8.90	.78	1.60	1.20	.39	.008	3.95

The ore in its natural state is as follows:

Admiral:

Moist.	Iron	Phos.	Silica
8.00	56.12	.037	6.35

Commodore:

10.90	51.70	.049	7.93

CORSICA MINE

Location: St. Louis county, Minn., Section 18, Township 58, Range 16.

Description: First opened up in 1901. This mine ships two grades of ore: CORSICA BESSEMER, a soft, red bessemer hematite, and CORSICA NONBESSEMER, a soft, red nonbessemer hematite. The mine is worked by the underground slicing system, the greatest vertical depth being 316 feet. The ore is shipped via the D. & I. R. railway to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Corsica Iron Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. C. David.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1901— 26,838 tons	1908— 77,674 tons	1915—160,655 tons
1902— 59,292 tons	1909—135,366 tons	1916—292,228 tons
1903— 34,043 tons	1910—277,537 tons	1917—289,083 tons
1904— 30,131 tons	1911— 63,940 tons	1918—384,692 tons
1905—	1912—196,188 tons	1919—340,588 tons
1906—100,606 tons	1913—225,140 tons	
1907—172,226 tons	1914— 99,613 tons	

Total, tons 3,065,835

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Corsica Bessemer:

Iron	Phos.	Silica	Mang.	Alum.
58.50	.041	9.50	.60	1.64

Corsica Nonbessemer:

55.00	.060	10.50	.70	3.05

The ore in its natural state is as follows:

Corsica Bessemer:

Moist.	Iron	Phos.	Silica
10.00	52.65	.037	8.65

Corsica Nonbessemer:

13.50	47.58	.052	9.08

CROSBY MINE

Location: Itasca county, Minn., Sections 31 and 32, Township 57, Range 22.

Description: First opened up in 1903. The washed ores are CROSBY, BESSEMER and CROSBY NONBESSEMER, and are soft, red bessemer and nonbessemer hematites. The mine is worked by the open-pit, milling, and underground slicing systems, the greatest vertical depth being 142 feet. The ore is shipped via the Great Northern railroad to Allouez, Wis., and thence by boat to the lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Nashwauk, Minn.

Manager: M. M. Duncan.

Superintendent: M. H. Barber.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1906—115,373 tons	1911— 18,439 tons	1916—110,652 tons
1907—227,265 tons	1912—188,368 tons	1917—187,938 tons
1908—152,084 tons	1913—219,065 tons	1918—185,558 tons
1909—183,470 tons	1914—	1919—116,753 tons
1910—159,569 tons	1915—	

Total, tons 1,864,534

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Crosby Bessemer:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.10	.045	8.64	.76	.96	.31	.18	.008	3.14

Crosby Nonbessemer:

60.00	.058	8.38	.80	.98	.34	.21	.010	3.38

The ore in its natural state is as follows:

Crosby Bessemer:

Moist.	Iron	Phos.	Silica
8.35	55.08	.041	7.92

Crosby Nonbessemer:

7.25	55.65	.054	7.77

CROXTON MINE

Location: St. Louis county, Minn., Section 13, Township 58 Range 20.

Description: First opened in 1902, but is now exhausted.

CYPRUS MINE

Location: St. Louis county, Minn., Section 3, Township 57, Range 21.

Description: First opened up in 1903, but is now exhausted.

Yearly Shipments:

1903—121,818 tons	1909—107,685 tons	1915— 25,566 tons
1904—244,343 tons	1910—102,233 tons	1916— 15,913 tons
1905—235,351 tons	1911— 81,178 tons	1917— 29,024 tons
1906—192,144 tons	1912—100,063 tons	1918— 21,649 tons
1907—260,948 tons	1913— 82,121 tons	1919—None
1908—115,745 tons	1914— 45,205 tons	

Total, tons 1,780,986

DALE MINE

Location: St. Louis county, Minn., S. W. ¼ of S. E. ¼ of Section 3, Township 57, Range 21.

Description: First opened up in 1911. The mine is exhausted.

Yearly Shipments:

1911—1,002,292 tons	1914— 423,711 tons	1917— 10,423 tons
1912—1,106,808 tons	1915— 116,336 tons	1918—
1913— 621,415 tons	1916— 29,971 tons	1919—

Total, tons 3,310,956

DANUBE MINE

Location: Itasca county, Minn., Section 20, Township 56 Range 24.

Description: First opened up in 1918. This mine ships two grades of ore: DANUBE BESSEMER, a soft, brown bessemer hematite, and DANUBE NONBESSEMER, a soft, brown hematite. The mine is worked by the open-pit method with washing plant in connection, the greatest vertical depth being 100 feet. The ore is shipped via the Great Northern railroad to Allouez, and thence by boat to the lower lake ports.

Operating Company: Balkan Mining Co., Keewatin, Minn.

Assistant General Manager: W. P. Chinn.

General Superintendent: F. P. Botsford.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1919—244,383 tons

Total, tons 244,383

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Danube:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.00	.060	11.20	.20	.57	.27	.26	.009	3.80

Danube Bessemer:

59.40	.040	10.27	.17	.53	.27	.26	.009	3.61

The ore in its natural state is as follows:

Danube:

Moist.	Iron	Phos.	Silica
8.40	53.13	.055	10.26

Danube Bessemer:

8.40	54.41	.037	9.41

DAY MINE

Location: St. Louis county, Minn., Section 31, Township 58, Range 20.

Description: First opened up in 1898. It is now combined with the Burt as the Burt-Pool-Day.

DEACON MINE

Location: St. Louis county, Minn., Sections 12 and 13, Township 58, Range 19.

Description: First opened up in 1914, but is practically exhausted.

Yearly Shipments:

1914— 87 tons	1916— 98,634 tons	1918— 71,154 tons
1915— 59,925 tons	1917—117,711 tons	1919—

Total, tons 347,511

DEAN-ITASCA MINE

Location: St. Louis county, Minn., Section 15, Township 58, Range 19.

Description: First opened up in 1915. This mine ships three grades of ore: CROWN, a soft, bessemer hematite; CRAWFORD and LAMBERT, both nonbessemer hematites. The mine is worked by the open-pit system. The ore is shipped via the Great Northern railroad to Allouez and then by boat to the lower lake ports.

Sales Agents: The Tod-Stambaugh Co., Cleveland, O.

Yearly Shipments:

1915—360,372 tons	1917—769,660 tons	1919—448,003 tons
1916—687,878 tons	1918—801,904 tons	

Total, tons 3,067,817

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Crown:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.30	.045	6.82	1.14	2.09	.24	.21	.013	4.31

Crawford:

57.50	.090	7.40	1.60	2.75	.08	.18	.015	5.80

Lambert:

57.10	.087	.58	1.40	2.54	.37	.26	.012	5.76

The ore in its natural state is as follows:

Crown:

Moist.	Iron	Phos.	Silica
11.95	52.21	.045	5.82

Crawford:

13.15	49.94	.078	6.43

Lambert:

13.64	49.31	.075	6.55

DRAPER MINE

Location: Itasca county, Minn., Section 10, Township 56, Range 23.

Description: First opened up in 1918. The ore is washed red, bessemer hematite. The mine is worked by the open-pit method. The ore is shipped via the Great Northern railroad to the G. N. docks at Allouez Bay, Wis., and thence by boat to the lower lake ports.

Operating Company: Draper Iron Co., Calumet, Minn.

Superintendent: S. N. Vivian.

General Superintendent: John F. Murphy.

Sales Agents: John A. Savage & Co., Duluth, Minn.

Yearly Shipments:

1918—	1919— 33,792 tons

Total tons, ...33,792

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.80	.037	8.94	.14	1.92	.31	.18	.001	2.98

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
8.61	55.57	.034	8.17

DULUTH MINE

Location: St. Louis county, Minn., Section 3, Township 58, Range 16.

Description: First opened up in 1893, but is now inactive.

Yearly Shipments:

1893— 37,626 tons	1899—165,435 tons	1905—142,172 tons
1894—	1900—128,587 tons	1906—158,336 tons
1895—	1901—150,024 tons	1907— 93,120 tons
1896—	1902—150,220 tons	1908—149,185 tons
1897—	1903—150,053 tons	1909—150,501 tons
1898—112,155 tons	1904—149,819 tons	1910— 57,239 tons

Total, tons 1,794,472

DUNCAN MINE

Location: St. Louis county, Minn., Sections 26 and 27, Township 58, Range 20.

Description: First opened up in 1914. This mine ships one grade of ore: GROUP 7, soft, reddish-brown, nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 218 feet. The ore is shipped via the D. M. & N. railroad Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn.
General Manager: J. M. McLean.
District Manager: M. H. Godfrey, Hibbing, Minn.
Yearly Shipments:

1914— 5,177 tons	1916— 5,198 tons	1918— 5,159 tons
1915— 5,152 tons	1917— 5,013 tons	1919— 5,250 tons

Total, tons 30,949

Analysis: See analysis of GROUP 7.

DUNWOODY MINE

Location: St. Louis county, Minn., Section 27, Township 58, Range 20.

Description: First opened up in 1917. The ore is a nonbessemer hematite. The mine is worked by the open-pit system. The ore is shipped via the Great Northern railway to Allouez, Wis., and thence by boat to the lower lake ports.

Sales Agents: The Tod-Stambaugh Co., Cleveland, O.
Yearly Shipments:

1917—369,739 tons	1918—625,877 tons	1919—535,930 tons

Total, tons 1,531,546

ELBA MINE

Location: St. Louis county, Minn., Section 13, Township 58, Range 17.

Description: First opened up in 1898. The ore is a soft, red, bessemer hematite. The mine is worked by the underground slicing system, the greatest vertical depth being 316 feet. The ore is shipped via the Duluth & Iron Range railroad to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Hobart Iron Co., Cleveland, O.
Assistant General Manager: W. P. Chinn.
General Superintendent: L. C. David.
Sales Agents: Pickands, Mather & Co., Cleveland, O.
Yearly Shipments:

1898— 564 tons	1906—255,580 tons	1914—147,796 tons
1899— 9,547 tons	1907—134,488 tons	1915—225,453 tons
1900—121,707 tons	1908—147,916 tons	1916—130,384 tons
1901—224,630 tons	1909—224,202 tons	1917—122,459 tons
1902—207,454 tons	1910—186,993 tons	1918— 81,236 tons
1903— 93,616 tons	1911—165,055 tons	1919—116,859 tons
1904—123,425 tons	1912—168,990 tons	
1905—125,724 tons	1913—126,236 tons	

Total, tons 3,140,314

Analysis: See LA BELLE.

EMMETT MINE (Formerly Atlas)

Location: St. Louis county, Minn., SW¼ of NW¼ of Section 8, Township 58 N, Range 16 W.

Description: First opened up in 1897. The mine is now idle.

Yearly Shipments:

1897— 18,614 tons	1902— 28,972 tons	1913— 13,387 tons
1898—	1910— 26,915 tons	1917— 15,977 tons
1899— 57,847 tons	1911—	1918— 29,361 tons
1900— 41,965 tons	1912— 12,384 tons	1919— 12,534 tons
1901— 42,756 tons		

Total, tons 300,712

ENTERPRISE MINE

Location: St. Louis county, Minn., Section 5, Township 58, Range 17.

Description: Mine not yet opened up. The ore will be mixed into the Hanna grade. The ore will be shipped via the Great Northern railway to Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.

Manager: E. E. Hunner.

General Superintendent: F. H. Cohoe.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

FAY MINE

Location: St. Louis county, Minn., NE¼, NE¼, Section 6, Township 58, Range 17.

Description: First opened up in 1912. The ore, HANNA, is a soft, brown nonbessemer hematite. The mine is operated as an underground mine, the greatest vertical depth being 125 feet. The ore is shipped via the Great Northern railroad to Allouez docks at Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.

Manager: E. E. Hunner.

Superintendent: F. H. Cohoe.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1912—262,070 tons	1915—	1918—
1913—296,059 tons	1916—	1919— 61,307 tons
1914—	1917—	

Total, tons 619,436

Analysis: See analysis of HANNA grade.

FAYAL MINE

Location: St. Louis county, Minn., Sections 5 and 6, Township 57, Range 17.

Description: First opened up in 1895. This mine ships three grades of ore: GROUP 1, a soft, light-brown nonbessemer hematite, GROUP 4, a soft, yellowish-brown nonbessemer hematite, and GROUP 5, a soft, dark-brown bessemer hema-

tite. The mine is worked by the underground and open-pit system, the greatest vertical depth being 428 feet. The ore is shipped via the D. & I. railroad to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Eveleth, Minn.

General Manager: J. H. McLean.

District Manager: W. J. West, Virginia, Minn.

Yearly Shipments:

1895— 136,601 tons	1904— 975,102 tons	1913—1,257,430 tons
1896— 248,645 tons	1905—1,358,922 tons	1914— 673,643 tons
1897— 642,939 tons	1906—1,634,853 tons	1915— 774,096 tons
1898— 575,933 tons	1907—1,878,812 tons	1916—2,288,799 tons
1899—1,072,257 tons	1908—1,439,879 tons	1917—2,037,705 tons
1900—1,252,504 tons	1909—1,879,357 tons	1918—1,366,083 tons
1901—1,656,973 tons	1910—1,485,099 tons	1919— 990,486 tons
1902—1,919,172 tons	1911— 434,364 tons	
1903—1,460,601 tons	1912— 468,019 tons	

Total, tons 29,908,274

Analysis: See analyses of GROUPS 1, 4 and 5.

FAULT MINE

Location: St. Louis county, Minn., Section 31, Township 58, Range 17.

Description: First opened up in 1917. The mine ships two grades of ore: FAULT BESSEMER, soft brown bessemer hematite, and FAULT, a soft, brown nonbessemer hematite. The mine is worked by the open-pit and top-slicing method, the greatest vertical depth being 85 feet. The ore is shipped via the D. & I. R. railway to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Fault Mining Co., Eveleth, Minn.

Manager: M. S. Kingston.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1917— 33,710 tons	1918—133,266 tons	1919— 38,152 tons

Total, tons 205,128

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Fault:

Iron	Phos.	Silica	Mang.	Alum.
56.50	.060	8.50	1.18	2.08

The ore in its natural state is as follows:

Fault:

Moist.	Iron	Phos.	Silica
13.00	49.16	.052	7.40

FOREST MINE

Location: Itasca county, Minn., SE¼ of NW¼ Section 13, Township 57, Range 22.

Description: First opened up in 1904, but is now idle.

Yearly Shipments:

1904— 85,280 tons	1908— 2,420 tons	1911—
1905— 99,785 tons	1909— 99,892 tons	1912—
1906— 41,647 tons	1910— 8,264 tons	1913—
1907— 4,840 tons		

Total, tons 248,540

FOWLER MINE

Location: St. Louis county, Minn., Section 3, Township 58, Range 15.

Description: First opened up in 1907. The ore is a soft, red, nonbessemer hematite. The mine is worked by the caving and slicing system, the greatest vertical depth being 132 feet. The ore is shipped via the Duluth & Iron Range railroad to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Aurora, Minn.

Manager: M. M. Duncan.

Superintendent: M. H. Barber.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1907— 34,014 tons	1912—204,584 tons	1916— 29,711 tons
1908— 21,511 tons	1913— 72,087 tons	1917— 11,137 tons
1909— 99,892 tons	1914— 12,364 tons	1918— 42,752 tons
1910—204,640 tons	1915—	1919— 49,940 tons
1911— 85,506 tons		

Total, tons 868,138

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.62	.051	10.81	1.04	1.95	.09	.10	.012	4.41

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
12.30	49.66	.045	9.48

FRANKLIN MINE

Location: St. Louis county, Minn., Section 9, Township 58, Range 17.

Description: First opened up in 1893. The ore is a soft, red and blue bessemer hematite. The mine is worked by the slicing system, the greatest vertical depth being 235 feet. The ore is shipped via the Duluth & Iron Range railway to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Company, Youngstown, O.

Manager: F. J. Webb.
Superintendent: Wm. White.
Sales Agents: Oglebay, Norton & Co., Cleveland.
Yearly Shipments:

1893—	46,617	tons	1902—	111,085	tons	1911—	66,351	tons
1894—	223,399	tons	1903—	92,019	tons	1912—	69,993	tons
1895—	286,423	tons	1904—	65,528	tons	1913—	51,760	tons
1896—	231,086	tons	1905—			1914—	28,885	tons
1897—	30,128	tons	1906—	66,935	tons	1915—	81,126	tons
1898—	200,400	tons	1907—	30,926	tons	1916—	54,002	tons
1899—	60,000	tons	1908—	8,246	tons	1917—	73,855	tons
1900—	168,524	tons	1909—	51,393	tons	1918—	32,888	tons
1901—	39,299	tons	1910—	31,614	tons	1919—	39,279	tons

Total, tons 2,241,761

FRANTZ MINE

Location: St. Louis county, Minn., Section 21, Township 58, Range 19.

Description: First opened up in 1904. The ore is a soft red, nonbessemer hematite. By grouping the ore from this mine with ores from the Mahoning mine, two grades of ore are produced: FRANTZ, a bessemer grade, and NELSON, a nonbessemer grade.

Operating Company: The Consumers' Ore Co., Virginia, Minn.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

1904—	62,884	tons	1910—			1916—		
1905—	70,210	tons	1911—			1917—	78,302	tons
1906—	11,068	tons	1912—			1918—	169,777	tons
1907—	907	tons	1913—			1919—	104,698	tons
1908—			1914—					
1909—			1915—					

Total, tons 497,846

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Frantz:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.65	.043	8.18	.44	2.73	.13	.11	.013	3.93

Nelson:

58.40	.062	8.27	.58	3.18	.34	.25	.013	3.71

The ore in its natural state is as follows:

Frantz:

Moist.	Iron	Phos.	Silica
12.37	51.40	.038	7.17

Nelson:

13.17	50.71	.054	7.18

GENOA MINE

Location: St. Louis county, Minn., Section 34, Township 58, Range 17.

Description: First opened up in 1896. The mine ships three

grades of ore: GROUP 1, a soft, dull-tan bessemer hematite, GROUPS 4 and 5, soft, dull-tan nonbessemer hematites. The mine is worked by the underground and open-pit systems, the greatest vertical depth being 368 feet. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Gilbert, Minn.
General Manager: J. H. McLean.
District Manager: W. J. West, Virginia, Minn.
Yearly Shipments:

1896—	17,136	tons	1904—	244,150	tons	1912—	1,315,840	tons
1897—	309,514	tons	1905—	281,081	tons	1913—	1,141,673	tons
1898—	279,677	tons	1906—	179,468	tons	1914—	476,972	tons
1899—	276,559	tons	1907—	108,610	tons	1915—	426,329	tons
1900—	253,651	tons	1908—			1916—	274,172	tons
1901—	332,022	tons	1909—			1917—	180,923	tons
1902—	399,719	tons	1910—	283,299	tons	1918—	177,978	tons
1903—	303,700	tons	1911—	923,477	tons	1919—	136,877	tons

Total, tons 8,322,827

Analysis: See analyses of GROUPS 1, 4 and 5.

GILBERT MINE

Location: St. Louis county, Minn., Section 26, Township 58, Range 17.

Description: First opened up in 1907, but is now inactive.

Yearly Shipments.

1907—	100,178	tons	1911—			1914—	1,300	tons
1908—	336,927	tons	1912—	135,622	tons	1915—		
1909—	783,683	tons	1913—	104,538	tons	1916—	70,187	tons
1910—	110,788	tons						

Total, tons 1,643,223

GLEN MINE

Location: St. Louis county, Minn., Section 29, Township 58, Range 20.

Description: First opened up in 1902. This mine ships four grades of ore, GROUP 2, a soft, brown bessemer hematite; GROUPS 3, 7 and 9, soft, reddish-brown nonbessemer hematites. The mine is worked by the underground system, the greatest vertical depth being 102 feet. The ore is shipped via the D., M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn.
General Manager: J. H. McLean.
District Manager: M. H. Godfrey, Hibbing, Minn.
Yearly Shipments:

1902—	23,875	tons	1908—	272,142	tons	1914—		
1903—	171,705	tons	1909—	396,591	tons	1915—	253,398	tons
1904—	280,412	tons	1910—	286,051	tons	1916—	284,889	tons
1905—	287,835	tons	1911—	113,512	tons	1917—	443,446	tons
1906—	279,424	tons	1912—			1918—	618,571	tons
1907—	205,426	tons	1913—	15	tons	1919—	481,629	tons

Total, tons 4,398,921

Analysis: See analyses of GROUPS 2, 3, 7 and 9.

G. N. NORTH UNO MINE

Location: St. Louis county, Minn., NE¼ of SW¼ of Section 2, Township 57, Range 21.

Description: First opened up in 1917. This mine ships two grades of ore, SMITH, a soft, red bessemer hematite and CONNOLLY, a soft, red nonbessemer hematite. The mine is worked by the open-pit system, the greatest vertical depth being 75 feet. The ore is shipped via the Great Northern railroad to Allouez, Wis., and thence by boat to the lower lake ports.

Operating Company: Butler Bros., St. Paul, Minn.

President: Walter Butler.

Superintendent: Emmett Butler.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1917— 3,754 tons	1918— 5,390 tons	1919— 27,606 tons

Total, tons 36,750

Analysis: See analyses of SMITH and CONNOLLY grades.

GRACE MINE

Location: St. Louis county, near Chisholm, Minn., Sections 33 and 34, Township 58, Range 20.

Description: First opened up in 1911, and is now worked out.

Yearly Shipments:

1911—	1914— 98,667 tons	1917— 81,815 tons
1912— 60,641 tons	1915— 70,783 tons	1918— 81,953 tons
1913—122,110 tons	1916— 81.289 tons	

Total, tons 597,258

GRAHAM MINE

Location: St. Louis county, Minn., Section 21, Township 59, Range 14.

Description: First opened up in 1912, but is now inactive.

Yearly Shipments:

1912—	1914—229,940 tons	1916—228,406 tons
1913—100,289 tons	1915—357,545 tons	1917—238,904 tons

Total, tons 1,155,084

GRANT MINE

Location: St. Louis county, Minn., Section 20, Township 58, Range 19.

Description: First opened up in 1902. This mine ships two grades of ore: GRANT, a soft, brown, nonbessemer hematite, and HAYES, a soft, bluish bessemer hematite. The mine is worked by the open-pit system, the greatest vertical depth being 200 feet. The ore is shipped via the Great Northern railway to the G. N. docks at Allouez, Wis., and thence by boat to lower lake ports.

Operating Company: Inter-State Iron Co., Jones & Laughlin Bldg., Pittsburgh, Pa.
General Superintendent: Mark Elliott.
Yearly Shipments:

1902— 51,946 tons	1910—297,761 tons	1914—111,443 tons
1903— 18,928 tons	1911—350,475 tons	1915—189,749 tons
1904— 44,413 tons	1912—399,848 tons	1916—110,604 tons
1905— 49,227 tons	1913—687,987 tons	1918—117,407 tons

Total, tons 2,429,788

Analysis: The expected analysis for 1920 is as follows: Dried at 212 degrees Fahr.

Grant:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.35	.103	6.42	.70	3.00	.44	.22	.016	4.19

Hayes:

58.28	.037	7.11	.75	3.63	.23	.16	.016	4.53

The ore in its natural state is as follows:

Grant:

Moist.	Iron	Phos.	Silica
14.00	51.04	.089	5.52

Hayes:

14.00	50.12	.032	6.12

GROUP ONE

This group is made up of ores from the following mines: Adams, Fayal, Genoa, Leonidas, Norman and Spruce. The ore is a soft, brown, bessemer hematite.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
60.09	.041	6.50	.60

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
12.24	52.74	.036	5.71

GROUP TWO

This group is made up of ores from the following mines: Burt, Canisteo, Chisholm, Clark, Glen, Holman, Hull-Rust, Kerr, Missabe Mountain, Morris, Ordean, Philbin, Sauntry-Alpena, Sellers, Shiras, Penobscot, Chester, Hartley-Burt-Palmer, Wanless and Arcturus.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
61.67	.049	4.90	.57

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.51	54.57	.043	4.34

GROUP THREE

This group is made up of ores from the following mines: Burt, Canisteo, Chester, Chisholm, Clark, Glen, Holman, Hull-

Rust, Kerr, Missabe Mountain, Morris, Ordean, Sauntry-Alpena, Sellers Shiras, Wanless, Carson Lake, Penobscot, Philbin and Arcturus.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
58.96	.082	6.09	.75

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
13.37	51.08	.071	5.28

GROUP FOUR

This group is made up of ores from the following mines: Adams, Canisteo, Fayal, Genoa, Leonidas, Norman, Ordean, Sauntry-Alpena, Spruce, Wanless, Chester, Clark and Hartley-Burt-Palmer.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
56.04	.070	8.26	1.12

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
14.61	47.86	.060	7.05

GROUP FIVE

This group is made up of ores from the following mines: Burt, Canisteo, Chester, Holman, Hull-Rust, Kerr, Missabe Mountain, Morris, Ordean, Sauntry-Alpena, Sellers, Shiras, Philbin, Chisholm, Adams Hartley-Burt-Palmer, Leonidas, Spruce, Fayal, Genoa.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
55.45	.045	13.68	.47

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.73	49.50	.040	12.22

GROUP SEVEN

This group is made up of ores from the following mines: Burt, Canisteo, Chester, Chisholm, Clark, Duncan, Glen, Holman, Hull-Rust, Kerr, Missabe Mountain, Morris, Ordean, Philbin, Sauntry-Alpena, Sellers, Shiras, Wanless, Carson Lake, Philbin, Hartley-Burt-Palmer, and Arcturus.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
55.34	.093	12.26	.58

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.58	48.93	.082	10.84

GROUP NINE

This group is made up of ores from the following mines: Burt, Chester, Chisholm, Clark, Glen, Hull-Rust, Kerr, Missabe-Mountain, Morris, Ordean, Sauntry-Alpena, Sellers, Wanless, Carson Lake, Penobscot, Philbin, Hartley-Burt-Palmer and Arcturus.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
56.71	.079	6.67	2.05

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
13.42	49.10	.069	5.78

GROUP TEN

This group is made up of ores from the following mines: Burt, Canisteo, Chester, Holman, Hull-Rust, Kerr, Morris, Sauntry-Alpena, Sellers, Chester, Missabe Mountain and Arcturus.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
52.45	.042	18.29	.46

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.66	46.86	.038	16.34

HANNA "A" MINE

Location: St. Louis county, Minn., Section 3, Township 58, Range 18.

Description: First opened up in 1907. The ore is a nonbessemer hematite. The mine is worked by the open-pit system, the greatest vertical depth being 175 feet. The ore is shipped via the Great Northern railroad to Allouez and thence by boat to the lower lake ports.

Operating Company: Consumers' Ore Co., Virginia, Minn.

Manager: Earl E. Hunner.

General Superintendent: C. E. Hendrick.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1909—238,873 tons	1913—264,318 tons	1917—136,114 tons
1910—308,009 tons	1914— 83,940 tons	1918—111,212 tons
1911— 26,252 tons	1915— 27,395 tons	1919— 4,676 tons
1912—211,822 tons	1916—124,021 tons	

Total, tons 1,536,632

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.40	.064	7.57	.86	1.91	.31	.27	0.16	6.83

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
12.40	50.28	.056	6.63

HANNA "B" MINE

Location: St. Louis county, Minn., Section 2, Township 58, Range 18.

Description: First opened up in 1913. This mine ships one ore, SHELBY, a soft, red nonbessemer hematite. The open-pit, steam-shovel method of mining is used. The greatest vertical depth is 110 feet. The ore is shipped via the D., M. & N. railroad to Duluth, and thence by boat to the lower lake ports.

Operating Company: Consumers' Ore Co., Virginia, Minn.
Manager: Earl E. Hunner.
General Superintendent: C. E. Hendrick.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments: See shipments of Hanna "A" mine.

HAROLD MINE

Location: St. Louis county, Minn., N. W. ¼ of N. W. ¼ of Section 11, Township 57, Range 21.

Description: First opened up in 1910. The mine ships a yellowish-brown high grade, nonbessemer hematite. The ore is not crushed. The mine is operated by underground methods, the greatest vertical depth being 170 feet. The ore is shipped via the Great Northern railway to Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.
Manager: E. E. Hunner.
General Superintendent: F. H. Cohoe.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

1910— 27,311 tons	1914—489,042 tons	1918—280,495 tons
1911—281,293 tons	1915— 86,340 tons	1919—231,428 tons
1912—187,926 tons	1916—216,567 tons	
1913— 92,054 tons	1917—145,966 tons	

Total, tons 2,038,822

Analysis: See HANNA grade.

HARRISON MINE

Location: Itasca county, Minn., NW¼ of NW¼ of Section 6, Township 56, Range 22, N½ of NE¼ and the SW¼ of NE¼ of Section 1, Township 56, Range 23.

Description: First opened up in 1914. This mine ships two grades of ore: COOLEY, a soft bessemer hematite, and KIPP, a soft nonbessemer hematite. The mine is worked by the open-pit system. The ore is shipped via the Great Northern railroad to Allouez Bay, Wis., and thence by boat to the lower lake ports.

Operating Company: Butler Bros., St. Paul, Minn.
President: Walter Butler, St. Paul, Minn.
Superintendent: A. J. Connolly.
Yearly Shipments:

1914—156,830 tons	1916— 32,876 tons	1918— 9,977 tons
1915—239,123 tons	1917— 21,107 tons	1919—119,877 tons

Total, tons 579,790

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Cooley:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.45	.040	10.85	.160	.800	.10	.11	.014	4.39

Kipp:

60.19	.058	9.00	.17	1.06	.11	.12	.015	3.43

The ore in its natural state is as follows:

Cooley:

Moist.	Iron	Phos.	Silica
8.07	53.73	.037	9.97

Kipp:

9.10	54.79	.053	8.18

HARTLEY-BURT-PALMER MINE

Location: St. Louis county, Minn., Sections 23 and 24, Township 58, Range 20.

Description: First opened up in 1906 This mine ships six grades of ore: GROUPS 2, 3, 4, 5, 7 and 9. The mine is worked by the open-pit system. The ore is shipped via the Great Northern railroad to Superior and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn.
General Manager: J. H. McLean.
District Manager: M. H. Godfrey, Hibbing, Minn.
Yearly Shipments:

1907— 334,646 tons	1912—	1917— 310,264 tons
1908— 55,462 tons	1913— 7,506 tons	1918— 954,154 tons
1909—	1914—	1919—1,064,838 tons
1910— 113,512 tons	1915—	
1911—	1916—	

Total, tons 2,840,382

Analysis: See analyses of GROUPS 2, 3, 4, 5, 7 and 9.

HAWKINS MINE

Location: Itasca county, Minn., Sections 31 and 32, Township 57 N, Range 22 W.

Description: First opened up in 1902. This mine ships two ores: NANOBE, a soft, red nonbessemer hematite, and HAWK-

INS, a soft, red bessemer hematite. The ores are crushed. The mine is worked by the open-pit system, the greatest vertical depth being 123 feet. The ore is shipped via the Great Northern railroad to Superior, and thence by boat to the lower lake ports.

Operating Company: Wisconsin Steel Co., Nashwauk, Minn.

Superintendent: B. W. Batchelder.

Sales Agents: Wisconsin Steel Co., Harvester Bldg., Chicago, Illinois.

Yearly Shipments:

1902— 5,892 tons	1908—248,246 tons	1914—232,354 tons
1903—107,905 tons	1909—316,783 tons	1915—327,749 tons
1904— 99,055 tons	1910—224,406 tons	1916—602,760 tons
1905—202,070 tons	1911—239,965 tons	1917—616,523 tons
1906—294,588 tons	1912—473,120 tons	1918—528,600 tons
1907—270,984 tons	1913—568,919 tons	1919—393,159 tons

Total, tons 4,853,078

Analysis: The average of all cargo analyses for 1919 is as follows:

Hawkins (Washed):

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.45	.044	8.49	.24	.73	.18	.25	...	2.21

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
8.96	55.03	.040	7.72

HECTOR MINE (Formerly Hale Mine)

Location: St. Louis county, Minn., Section 1, Township 58, Range 16.

Description: First opened up in 1893. The mine is exhausted.

Yearly Shipments:

1893— 3,616 tons	1900— 32,901 tons	1907— 65,952 tons
1894— 24,167 tons	1901— 30,929 tons	1908—
1895— 31,004 tons	1902— 54,289 tons	1909— 30,726 tons
1896— 70,006 tons	1903—	1910— 82,393 tons
1897— 13,728 tons	1904—	1911— 20,264 tons
1898—	1905— 4,990 tons	1918—207,498 tons
1899— 18,807 tons	1906— 37,221 tons	

Total, tons 728,851

HELMER MINE

Location: St. Louis county, Minn., Section 14, Township 58, Range 19.

Description: First opened up in 1910. This mine is operated in conjunction with the Wade mine, and entire tonnage produced is shipped as Wade. The ore is a soft, dark-brown nonbessemer hematite, and is partially crushed. The mine is

worked by the open-pit system, the greatest vertical depth being 145 feet. The ore is shipped via the D. M. & N. railroad to the D. M. & N. docks at Duluth, and thence by boat to lower lake ports.

Operating Company: Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: M. H. Barber.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1913— 25,641 tons	1916—395,615 tons	1919— 74,657 tons
1914—151,803 tons	1917—259,777 tons	
1915—101,799 tons	1918—207,498 tons	

Total, tons 1,216,790

Analysis: See analysis of WADE ore.

HIGGINS MINE

Location: St. Louis county, Minn., Section 4, Township 58, Range 17.

Description: First opened up in 1904, but is now inactive.

Yearly Shipments:

1904— 35,286 tons	1909—322,504 tons	1914—
1905—238,598 tons	1910—151,854 tons	1915—
1906—341,319 tons	1911— 250 tons	1916—162,216 tons
1907—173,439 tons	1912—	
1908—	1913—	

Total, tons 1,425,466

HILL MINE

Location: Itasca county, Minn., Section 17, Township 56, Range 23.

Description: First opened up in 1910 but is now inactive.

Operating Company: Oliver Iron Mining Co., Marble, Minn.

Yearly Shipments:

1910— 801,088 tons	1913— 855,965 tons	1916— 552,104 tons
1911—1,550,568 tons	1914— 592,590 tons	
1912—1,188,908 tons	1915— 998,649 tons	

Total, tons 6,539,872

HILL-TRUMBULL MINE

Location: Itasca county, Minn., Section 17, Township 56, Range 23.

Description: The Hill mine was opened up in 1910 and the Trumbull in 1919. The ore is a hematite. The mine is worked by the open-pit system. The ore is shipped via the Great Northern railroad to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: The Mesaba-Cliffs Iron Mining Co., Marble, Minn.
Manager: M. M. Duncan.
Superintendent: M. H. Barber.
Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.
Yearly Shipments:

1910— 801,088 tons	1914— 592,590 tons	1918— 559,074 tons
1911—1,550,568 tons	1915— 998,649 tons	1919— 575,509 tons
1912—1,188,908 tons	1916— 552,104 tons	
1913— 855,965 tons	1917—	

Total, tons 7,674,455

Analysis: The average of all cargo analyses for 1919 is as follows:. Dried at 212 degrees Fahr.

Hill Bessemer:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.00	.045	8.50	.25	.90	.08	.20	.020	3.00

Trumbull:

60.00	.075	8.50	.50	.95	.08	.20	.02	3.10

The ore in its natural state is as follows:

Hill Bessemer:

Moist.	Iron	Phos.	Silica
8.35	55.00	.041	7.79

Trumbull:

8.00	55.20	.069	7.82

HOBART MINE

Location: St. Louis county, Minn., Section 25, Township 58, Range 17.

Description: First opened up in 1906. The ore which is mixed into the Hanna Grade is a soft, red nonbessemer hematite. The mine is worked by the underground method. The ore is shipped via the Great Northern railway to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.
Manager: E. E. Hunner.
General Superintendent: F. H. Cohoe.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

1906— 975 tons	1907— 7,339 tons	1919— 48,408 tons

Total, tons 56,722

HOLMAN MINE

Location: Itasca county, Minn., Sections 21 and 22, Township 56, Range 24.

Description: First opened up in 1907. This mine ships six grades of ore: GROUPS 2, 5 and 10, soft, brown bessemer hematites, GROUPS 3, 7 and 9, soft, brown nonbessemer hematites. The mine is worked by the underground and open-pit

systems. The ore is shipped via the D. M. & N. railroad to Duluth and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Taconite, Minn.
General Manager: J. H. McLean.
District Manager: M. H. Godfrey, Hibbing, Minn.
Yearly Shipments:

1907— 8,068 tons	1912—919,699 tons	1917—835,464 tons
1908— 1,682 tons	1913—751,422 tons	1918—736,527 tons
1909—391,157 tons	1914—497,276 tons	1919—515,660 tons
1910—413,873 tons	1915—845,898 tons	
1911—779,889 tons	1916—610,281 tons	

Total, tons 7,306,896

Analysis: See analyses of GROUPS 2, 3, 5, 7, 9 and 10.

HUDSON MINE

Location: St. Louis county, Minn., Section 4, Township 58, Range 15.

Description: First opened up in 1910, but is now exhausted.

Yearly Shipments:

1910—168,553 tons	1914—127,526 tons	1918— 84,744 tons
1911— 67,278 tons	1915—196,952 tons	1919—
1912—224,548 tons	1916—110,510 tons	
1913—240,513 tons	1917— 78,963 tons	

Total, tons 1,299,587

HULL-RUST MINE

Location: St. Louis county, Minn., Section 1 and 2, Township 57, Range 21.

Description: First opened up in 1896. This mine ships six grades of ore: GROUP 2, a soft, black bessemer hematite, GROUPS 5 and 10, soft, yellowish-red bessemer hematites, GROUPS 3 and 9, soft, reddish-brown nonbessemer hematites and GROUP 7, a soft, yellowish-red nonbessemer hematite. The mine is worked by the open-pit system, the greatest vertical depth being 231 feet. The ore is shipped via the D. M. & N. railroad to Duluth, and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.
General Manager: J. H. McLean.
District Manager: M. H. Godfrey, Hibbing, Minn.
Yearly Shipments:

1896— 31,982 tons	1904— 260,241 tons	1912—2,232,112 tons
1897— 188,140 tons	1905— 505,179 tons	1913—3,457,608 tons
1898— 119,302 tons	1906—2,257,420 tons	1914— 458,468 tons
1899— 134,062 tons	1907—3,271,214 tons	1915—2,294,405 tons
1900— 172,041 tons	1908—3,316,782 tons	1916—7,665,611 tons
1901— 476,585 tons	1909—3,039,911 tons	1917—6,461,443 tons
1902— 665,981 tons	1910—3,189,975 tons	1918—5,452,585 tons
1903— 600,331 tons	1911— 496,977 tons	1919—5,100,555 tons

Total, tons 51,848,910

Analysis: See analyses of GROUPS 2, 3, 5, 7, 9 and 10.

IROQUOIS MINE

Location: St. Louis county, Minn., Section 10, Township 58, Range 18.

Description: First opened up in 1903. Idle since 1914. The ore is a soft, red-brown hematite. Mine was worked by underground caving and slicing system and by the open-pit milling system.

Operating Company: Clement K. Quinn & Co.

Manager: Clement K. Quinn.

General Superintendent: Edward P. Scallon.

Sales Agents: Clement K. Quinn & Co.

Yearly Shipments:

1903— 17,562 tons	1907—254,329 tons	1911— 43,310 tons
1904— 50,215 tons	1908—151,071 tons	1912— 80,000 tons
1905— 61,109 tons	1909—152,510 tons	1913—111,159 tons
1906—190,971 tons	1910—231,842 tons	1914— 14,334 tons

Total, tons 1,358,412

JEAN MINE

Location: St. Louis county, Minn., Section 31, Township 58, Range 17.

Description: First opened up in 1916, but is now idle.

Operating Company: Kingston Mining Co., Virginia, Minnesota.

Manager: M. S. Kingston.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1916— 3,927 tons	1918— 26,688 tons
1917— 78,522 tons	1919— 7,122 tons

Total, tons 116,259

JENNINGS MINE

Location: St. Louis county, Minn., Section 14, Township 58, Range 19.

Description: First opened up in 1906, but is now idle.

Yearly Shipments:

1906— 84,715 tons	1908— 18,313 tons
1907— 99,812 tons	1909— 10,477 tons

Total, tons ..... 213,317.

JORDAN MINE

Location: St. Louis county, Minn., Section 22, Township 58, Range 20.

Description: First opened up in 1902, but is now idle.

Yearly Shipments:

1902—147,931 tons	1905—185,854 tons	1908—118,529 tons
1903—190,024 tons	1906—110,768 tons	1909— 12,754 tons
1904— 97,474 tons	1907— 61,996 tons	1910— 20,314 tons

Total, tons 945,644

JUDD MINE

Location: Itasca county, Minn., Section 21, Township 56, Range 24.

Description: First opened up in 1913, but is now inactive.

Operating Company: Oliver Iron Mining Co., Taconite, Minn.

Yearly Shipments:

1913—103,495 tons	1916— 50,263 tons	1919—
1914— 95,416 tons	1917— 50,278 tons	
1915—334,685 tons	1918—	

Total, tons 634,137

KERR MINE

Location:. St. Louis county, Minn., Sections 3, 34 and 35, Township 57 and 58, Range 21.

Description: First opened up in 1916. This mine ships six grades of ore: GROUP 2, a soft, brown-black bessemer hematite; GROUP 5, a soft, reddish-brown bessemer hematite; GROUP 10, a soft yellowish-red bessemer hematite; GROUP 3 and GROUP 9, soft, reddish-brown nonbessemer hematites, and GROUP 7, a soft yellowish-red nonbessemer hematite. The mine is worked by the open-pit system. The ore is shipped via the D. M. & N. Railroad to Duluth, Minn., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean.

District Manager: M. H. Godfrey, Hibbing, Minn.

Yearly Shipments:

1916— 539,675 tons	1918—2,027,589 tons
1917—1,586,409 tons	1919—1,693,523 tons

Total, tons 5,847,196

Analysis: See analyses of GROUPS 2, 3, 5, 7, 9 and 10.

KEVIN MINE

Location: Itasca county, Minn., NW¼ of SW¼ of Section 1, Township 56, range 23.

Description: First opened up in 1916. The ore, KIPP, is a soft, nonbessemer hematite. The mine is worked by the open-pit system. The greatest vertical depth being 50 feet. The ore is shipped via the Great Northern railroad to Allouez Bay, Wis., and thence by boat to the lower lake ports.

Operating Company: Butler Bros., St. Paul, Minn.

President: Walter Butler, St. Paul, Minn.

Superintendent: A. J. Conolly.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1916—267,292 tons	1918— 21,602 tons
1917— 35,878 tons	1919— 32,617 tons

Total, tons 357,389

Analysis: See analysis of KIPP ore.

Rust, Kerr, Missabe Mountain, Morris, Ordean, Sauntry-Alpena, Sellers Shiras, Wanless, Carson Lake, Penobscot, Philbin and Arcturus.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
58.96	.082	6.09	.75

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
13.37	51.08	.071	5.28

GROUP FOUR

This group is made up of ores from the following mines: Adams, Canisteo, Fayal, Genoa, Leonidas, Norman, Ordean, Sauntry-Alpena, Spruce, Wanless, Chester, Clark and Hartley-Burt-Palmer.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
56.04	.070	8.26	1.12

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
14.61	47.86	.060	7.05

GROUP FIVE

This group is made up of ores from the following mines: Burt, Canisteo, Chester, Holman, Hull-Rust, Kerr, Missabe Mountain, Morris, Ordean, Sauntry-Alpena, Sellers, Shiras, Philbin, Chisholm, Adams Hartley-Burt-Palmer, Leonidas, Spruce, Fayal, Genoa.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
55.45	.045	13.68	.47

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.73	49.50	.040	12.22

GROUP SEVEN

This group is made up of ores from the following mines: Burt, Canisteo, Chester, Chisholm, Clark, Duncan, Glen, Holman, Hull-Rust, Kerr, Missabe Mountain, Morris, Ordean, Philbin, Sauntry-Alpena, Sellers, Shiras, Wanless, Carson Lake, Philbin, Hartley-Burt-Palmer, and Arcturus.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
55.34	.093	12.26	.58

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.58	48.93	.082	10.84

GROUP NINE

This group is made up of ores from the following mines: Burt, Chester, Chisholm, Clark, Glen, Hull-Rust, Kerr, Missabe-Mountain, Morris, Ordean, Sauntry-Alpena, Sellers, Wanless, Carson Lake, Penobscot, Philbin, Hartley-Burt-Palmer and Arcturus.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
56.71	.079	6.67	2.05

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
13.42	49.10	.069	5.78

GROUP TEN

This group is made up of ores from the following mines: Burt, Canisteo, Chester, Holman, Hull-Rust, Kerr, Morris, Sauntry-Alpena, Sellers, Chester, Missabe Mountain and Arcturus.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
52.45	.042	18.29	.46

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.66	46.86	.038	16.34

HANNA "A" MINE

Location: St. Louis county, Minn., Section 3, Township 58, Range 18.

Description: First opened up in 1907. The ore is a nonbessemer hematite. The mine is worked by the open-pit system, the greatest vertical depth being 175 feet. The ore is shipped via the Great Northern railroad to Allouez and thence by boat to the lower lake ports.

Operating Company: Consumers' Ore Co., Virginia, Minn.

Manager: Earl E. Hunner.

General Superintendent: C. E. Hendrick.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1909—238,873 tons	1913—264,318 tons	1917—136,114 tons
1910—308,009 tons	1914— 83,940 tons	1918—111,212 tons
1911— 26,252 tons	1915— 27,395 tons	1919— 4,676 tons
1912—211,822 tons	1916—124,021 tons	

Total, tons 1,536,632

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.40	.064	7.57	.86	1.91	.31	.27	0.16	6.83

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
12.40	50.28	.056	6.63

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Smith:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
61.20	.038	8.50	.38	.82	.50	.38	.035	1.81

Connolly:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.60	.062	8.48	.72	1.66	.22	.10	.010	4.44

The ore in its natural state is as follows:

Smith:

Moist.	Iron	Phos.	Silica
7.72	56.48	.035	7.84

Connolly:

Moist.	Iron	Phos.	Silica
10.48	52.46	.056	7.59

LARKIN MINE (Formerly Tesora Mine)

Location: St. Louis county, Minn., N. E. ¼ of N. E. ¼, Section 4, Township 58, Range 17.

Description: First opened up in 1906, but is now inactive.

Yearly Shipments:

1906— 12,001 tons	1909— 46,651 tons	1912— 16,542 tons
1907— 22,040 tons	1910— 21,700 tons	1913— 69,200 tons
1908— 14,030 tons	1911— 2,668 tons	

Total, tons 204,832

LA RUE MINE

Location: Itasca county, Minn., Sections 29 and 32, Township 57, Range 22.

Description: First opened up in 1902. Two ores are shipped from this mine: LA RUE, a soft, red bessemer hematite, and NASHWAUK, a soft, red nonbessemer hematite. The open-pit system of mining is used, the greatest vertical depth being 80 feet. The ore is shipped via the Great Northern railroad to Allouez Bay, and thence by boat to the lower lake ports.

Operating Company: La Rue Mining Co., Virginia, Minn.

Manager: Earl E. Hunner.

General Superintendent: C. E. Hendrick.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1903— 53,335 tons	1909—365,543 tons	1915— 24,911 tons
1904—105,170 tons	1910—128,658 tons	1916—253,402 tons
1905—197,192 tons	1911— 30,141 tons	1917—330,349 tons
1906—175,670 tons	1912—155,552 tons	1918—295,916 tons
1907—301,522 tons	1913—172,332 tons	1919—234,453 tons
1908— 79,313 tons	1914— 24,700 tons	

Total, tons 2,928,158

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

La Rue:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.25	.034	8.63	.33	.63	.23	.17	.007	6.07

Nashwauk:

57.24	.056	9.60	.68	1.07	.27	.25	.009	6.18

The ore in its natural state is as follows:

La Rue:

Moist.	Iron	Phos.	Silica
9.12	53.85	.031	7.84

Nashwauk:

9.59	51.75	.051	8.68

LAURA MINE

Location: St. Louis county, Hibbing Minn., Section 31, Township 58, Range 20.

Description: First opened up in 1894. The ore is a soft, red nonbessemer hematite. Underground caving system of mining is used. The ore is shipped via the Great Northern railroad to Superior, and thence by boat to the lower lake ports.

Operating Company: Inland Steel Co., Chicago.

Yearly Shipments:

1902— 16,453 tons	1908—176,725 tons	1914—198,665 tons
1903— 79,286 tons	1909—178,110 tons	1915—132,081 tons
1904— 3,778 tons	1910—189,046 tons	1916—188,569 tons
1905— 27,207 tons	1911—238,824 tons	1917—105,515 tons
1906—138,001 tons	1912—270,411 tons	1918—141,736 tons
1907—149,410 tons	1913—184,530 tons	1919—129,954 tons

Total, tons 25,483,301

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
55.12	.072	7.10	1.07

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
15.01	46.85	.061	6.03

LEETONIA MINE

Location: St. Louis county, Minn., Section 10, Township 57, Range 21.

Description: First opened up in 1902. The ore is a soft, red, nonbessemer hematite. The mine is worked by the underground, top-slicing and caving and open-pit steam shovel systems, the greatest vertical depth being 182 feet. The ore is

shipped via the Great Northern railway to the G. N. docks at Allouez, Wis., and thence by boat to lower lake ports.

Operating Company: Leetonia Mining Co., Jones & Laughlin Bldg., Pittsburgh, Pa.

General Superintendent: Mark Elliott.

Yearly Shipments:

1902— 28,784 tons	1908—289,490 tons	1914—551,022 tons
1903—200,163 tons	1909—553,162 tons	1915—607,447 tons
1904—228,536 tons	1910—615,396 tons	1916—656,876 tons
1905—352,004 tons	1911—353,063 tons	1917—402,868 tons
1906—308,989 tons	1912—368,301 tons	1918—230,865 tons
1907—301,368 tons	1913—501,248 tons	1919—374,963 tons

Total, tons 6,924,545

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.72	.054	9.59	.60	1.17	.14	.13	.029	5.38

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.17	51.27	.048	8.52

LEONARD MINE

Location: St. Louis county, Minn., W. ½ of S. W. ¼ of Section 28, Township 58, Range 20.

Description: First opened up in 1903. The ore is a soft, non-bessemer hematite. The mine is worked by the underground and open-pit methods, the greatest vertical depth being 253 feet. The ore is shipped via the Great Northern railway to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.

Manager: E. E. Hunner.

General Superintendent: F. H. Cohoe.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1903— 10,591 tons	1909— 6,857 tons	1915— 197,599 tons
1904—151,952 tons	1910— 795,431 tons	1916— 316,468 tons
1905—297,011 tons	1911—1,293,463 tons	1917— 305,537 tons
1906—254,368 tons	1912—2,198,119 tons	1918— 737,209 tons
1907—137,316 tons	1913—2,252,367 tons	1919— 235,930 tons
1908—	1914—2,686,285 tons	

Total, tons 10,877,503

Analysis: See analysis of HANNA grade.

LEONIDAS MINE

Location: St. Louis county, Minn., Section 36, Township 58, Range 18.

Description: First opened up in 1912. This mine ships three grades of ore: GROUP 1, a soft, dull, mahogany-brown bessemer hematite, GROUPS 4 and 5, soft, dark-brown

nonbessemer hematites. The mine is worked by the underground system, the greatest vertical depth being 448 feet. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Eveleth, Minn.

General Manager: J. H. McLean.

District Manager: W. J. West, Virginia, Minn.

Yearly Shipments:

1914— 232,416 tons	1916—1,147,105 tons	1918— 656,735 tons
1915— 732,777 tons	1917— 795,826 tons	1919— 293,634 tons

Total, tons 3,858,493

Analysis: See analyses of GROUPS 1, 4 and 5.

LILEY MINE

Location: St. Louis county, Minn., Section 16, Township 58, Range 17.

Description: First opened up in 1907, but is now idle.

Yearly Shipments:

1907— 31,032 tons	1909—
1908— 51,143 tons	1910— 25,404 tons

Total, tons 107,579

LINCOLN MINE

Location: St. Louis county, Minn., Sections 4 and 5, Township 58, Range 17.

Description: First opened up in 1902. This mine ships two grades of ore: DOUGLAS, a soft, bluish-brown, bessemer hematite, and STANTON, a soft, light-brown, nonbessemer hematite. The mine is worked by the underground top slicing and caving systems, the greatest vertical depth being 237 feet. The ore is shipped via the Duluth, Missabe & Northern railway to the D., M. & N. docks at Duluth, Minn., and thence by boat to lower lake ports.

Operating Company: Inter-State Iron Co., Jones & Laughlin Bldg., Pittsburgh, Pa.

General Superintendent: Mark Elliott.

Yearly Shipments:

1902— 87,908 tons	1908—379,219 tons	1914—207,251 tons
1903—279,399 tons	1909—303,066 tons	1915—239,142 tons
1904—153,822 tons	1910—318,912 tons	1916—286,128 tons
1905—275,777 tons	1911—208,556 tons	1917—276,678 tons
1906—367,192 tons	1912—173,979 tons	1918—295,677 tons
1907—297,870 tons	1913—215,957 tons	1919—240,838 tons

Total, tons 4,607,371

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Douglas:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.73	.029	10.59	.42	.95	.14	.14	.015	2.37

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
6.70	55.73	.027	9.88

LONE JACK MINE

Location: St. Louis county, Minn., Section 9, Township 58, Range 17.

Description. First opened up in 1895, but is now inactive.

Operating Company: Oliver Iron Mining Co., Virginia, Minn.

Yearly Shipments:

1895—389,338	tons	1904—		1913—	
1896—681,957	tons	1905— 46,067	tons	1914—	
1897—455,580	tons	1906—		1915— 21,560	tons
1898—275,621	tons	1907— 99,601	tons	1916— 61,994	tons
1899— 6,569	tons	1908—		1917—	
1900—168,005	tons	1909—		1918— 4,106	tons
1901—		1910—		1919—	
1902—		1911—			
1903—		1912—			

Total, tons 2,210,398

LONGYEAR MINE

Location: St. Louis county, Minn., Section 5, Township 57, Range 20.

Description: First opened up in 1902. Property was operated by underground methods from 1902 to 1905, stripped and operated by open-pit methods in 1913. No operations subsequent to 1913. The ore was a soft, brown bessemer and nonbessemer hematite. The greatest vertical depth is 290 feet. The ore was shipped via the Great Northern railway to the G. N. docks at Allouez, Wis., and thence by boat to lower lake ports.

Operating Company: Inter-State Iron Co., Jones & Laughlin Bldg., Pittsburgh, Pa.

General Superintendent: Mark Elliott.

Yearly Shipments:

1902— 22,788	tons	1904— 221	tons	1913— 11,799	tons
1903— 81,604	tons	1905— 16,778	tons		

Total, tons 133,190

MACE NO. 1 MINE

Location: St. Louis county, Minn., Section 7, Township 57, Range 21.

Description: The mine was first opened up by the Oliver Iron Mining Co. in 1910. It was taken over by the Mace Iron Mining Co., Jan. 1, 1915. This mine ships one grade of ore, MACE, a soft, yellow bessemer hematite. The mine is worked by the underground system, the greatest vertical

depth being 94 feet. The ore is shipped via the Great Northern railroad to the G. N. docks at Allouez, Wis., and thence by boat to the lower lake ports.

Operating Company: Mace Iron Mining Co., 709 Security Bldg., Minneapolis, Minn.

Secretary and General Manager: O. B. Warren.

Superintendent: J. A. MacKillican.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1910— 15,267 tons	1914—160,815 tons	1918— 66,405 tons
1911—125,013 tons	1915—120,888 tons	1919—
1912—136,282 tons	1916—163,352 tons	
1913—141,241 tons	1917—122,500 tons	

Total tons 1,051,764

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.93	.032	10.52	.39	.55	.55	.36	.007	1.92

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
8.50	54.84	.029	9.63

MACE NO. 2 MINE

Location: Itasca county, Minn., Section 29, Township 57, Range 22.

Description: First opened up in 1915. The ore, MACE, is a soft, red bessemer hematite. The mine is worked by the open-pit system. The ore is shipped via the Great Northern railroad to the G. N. docks, at Allouez, Wis., and thence by boat to the lower lake ports. The Mace No. 1 and Mace No. 2 mine ores are mixed at the docks and shipped as MACE grade ore.

Operating Company: Mace Iron Mining Co., 709 Security Bldg., Minneapolis, Minn.

Secretary and General Manager: O. B. Warren.

Superintendent: J. A. MacKillican.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1916—307,497 tons	1918—247,590 tons
1917—251,280 tons	1919—112,228 tons

Total, tons 918,655

MADRID MINE

Location: St. Louis county, Minn., Section 8, Township 58 N., Range 17 W.

Description: First opened up in 1912. The mine ships two grades of ore: MADRID No. 1, a soft, reddish-brown besse-

mer hematite, and MADRID No. 2, a soft, reddish-brown, medium-coarse bessemer hematite. All the ore is washed and shipped as a washed product. The mine is worked by the underground caving system, the greatest vertical depth being 132 feet. The ore is shipped via the D. M. & N. railroad to the D. M. & N. docks at Duluth, and thence by boat to lower lake ports.

Operating Company: Wawbeek Mining Co., Alworth Building, Duluth, Minn.

Manager: Clement K. Quinn.

General Superintendent: Edward P. Scallon.

Sales Agents: Clement K. Quinn & Co. Duluth, Minn., and Cleveland, O.

Yearly Shipments:

1912—	26,906 tons	1915—		1918—	18,258 tons
1913—	86,053 tons	1916—		1919—	8,254 tons
1914—	9,951 tons	1917—	43,943 tons		

Total, tons 193,365

Analysis: Dried at 212 degrees Fahr.

Madrid No. 1:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.10	.022	15.00	.87	1.12	.21	.23	0.25	2.17

Madrid No. 2:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.03	.038	16.16	.87	1.29	.21	.23	.025	2.17

The ore in its natural state is as follows:

Madrid No. 1:

Moist.	Iron	Phos.	Silica
7.00	53.10	.020	13.95

Madrid No. 2:

Moist.	Iron	Phos.	Silica
7.00	51.17	.035	15.03

MAHONING MINE

Location: St. Louis county, Minn., Sections 1 and 2, Township 57, Range 22.

Description: First opened up in 1895. This mine ships two ores: MAHONING, a soft, blue bessemer hematite, and BEAVER, a soft, brown nonbessemer hematite. The mine is worked by the open-pit system, the greatest vertical depth being 270 feet. The ore is shipped via the Great Northern railroad to Allouez Bay, Wis., and thence by boat to the lower lake ports.

Operating Company: Mahoning Ore & Steel Co., Hibbing, Minn.

Manager: W. C. Agnew.

Superintendent: R. N. Marble.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1895— 117,884 tons	1903—1,009,446 tons	1912—1,518,643 tons
1896— 167,245 tons	1904— 706,325 tons	1913—1,515,428 tons
1897— 519,892 tons	1905—1,001,661 tons	1914—1,212,287 tons
1898— 520,751 tons	1906—1,274,232 tons	1915—2,311,940 tons
1899— 750,341 tons	1907—1,564,336 tons	1916—2,215,788 tons
1900— 911,021 tons	1908— 611,592 tons	1917—2,524,110 tons
1901— 765,872 tons	1909—1,561,893 tons	1918—2,024,595 tons
1902—1,038,645 tons	1911—1,011,945 tons	1919—1,237,167 tons

Total, tons 29,618,758

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Mahoning:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
64.34	.041	2.39	.22	1.47	.44	.41	.022	2.98

Beaver:

61.77	.083	4.00	.41	2.59	.36	.27	.015	3.72

The ore in its natural state is as follows:

Mahoning:

Moist.	Iron	Phos.	Silica
10.14	57.82	.037	2.15

Beaver:

12.55	54.02	.073	3.50

MAJORCA MINE (Formerly Sullivan & Hale)

Location: Itasca county, Minn., Section 9, Township 56, Range 23.

Description: First opened up in 1917. The ores, MAJORCA BESSEMER and MAJORCA NONBESSEMER are both soft, brown hematites. The mine is worked by the open-pit system, the greatest vertical depth being 75 feet. A washing plant is operated in connection with the mine. The ore is shipped via the Great Northern railroad to Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Hobart Iron Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: F. P. Botsford.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1917—112,314 tons	1918—251,707 tons	1919—219,337 tons

Total, tons 583,358

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Majorca:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.10	.057	12.90	.16	1.26	.25	.11	.014	2.60

Majorca Bessemer:

57.65	.044	13.77	.06	1.07	.14	.09	.006	2.13

The ore in its natural state is as follows:

Majorca:

Moist.	Iron	Phos.	Silica
9.00	52.87	.052	11.74

Majorca Bessemer:

8.00	53.04	.040	12.67

MARGARET MINE

Location: St. Louis county, Minn., W½ of SE¼ of Section 16, Township 58, Range 19.

Description: First opened up in 1918. This mine ships two grades of ore: SMITH, a soft, red bessemer hematite, and CONNOLLY, a soft, red nonbessemer hematite. The mine is worked by the open-pit and steam-shovel systems, the greatest vertical depth being 90 feet. The ore is shipped via the Great Northern railroad to the G. N. docks at Allouez, Wis., and thence by boat to the lower lake ports.

Operating Company: Butler Bros., St. Paul, Minn.

President: Walter Butler.

Superintendent: John Butler.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1918— 43,932 tons 1919— 48,185 tons

Total, tons 92,117

Analysis: See analyses of Smith and Connolly grades.

MARISKA MINE

Location: St. Louis county, Minn., Section 24, Township 58, Range 17.

Description: First opened up in 1907. The mine is now idle.

Yearly Shipments:

1907— 137 tons	1909— 77,690 tons	1911— 2,367 tons
1908— 30,226 tons	1910— 23,265 tons	

Total, tons 133,685

MALTA MINE

Location: St. Louis county, Minn., Section 35, Township 58, Range 17.

Description: First opened up in 1899, but is now exhausted.

Yearly Shipments:

1899— 28,615 tons	1905—139,853 tons	1911— 10,608 tons
1900— 65,346 tons	1906—115,763 tons	1912— 2,817 tons
1901—126,299 tons	1907— 82.062 tons	1913— 93,632 tons
1902—222,640 tons	1908— 93,072 tons	1914—
1903— 11,695 tons	1909— 92,356 tons	1915—
1904— 66,641 tons	1910— 72,035 tons	1916— 66,573 tons

Total, tons 1,289,990

McKINLEY MINE

Location: St. Louis county, Minn., Section 8, Township 58, Range 16.

Description: First opened up in 1907, but is now inactive.

Yearly Shipments:

1907—	17,705 tons	1909—	89,981 tons
1908—	1,399 tons	1910—	

Total, tons 109,086

MEADOW MINE

Location: St. Louis county, Minn., Section 3, Township 58, Range 15.

Description: First opened up in 1910. The ore is a soft, red, nonbessemer hematite. The mine is worked by top and side slicing, the greatest vertical depth being 250 feet. The ore is shipped via the Duluth & Iron Range railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: The Cleveland Cliffs Iron Co., Aurora, Minn.

Manager: M. M. Duncan.

Superintendent: M. H. Barber.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1910—	4,392 tons	1914—	38,750 tons	1918—	52,515 tons
1911—		1915—	41,182 tons	1919—	30,394 tons
1912—	10,629 tons	1916—	50,763 tons		
1913—	25.106 tons	1917—	96,191 tons		

Total, tons 349,922

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.00	.062	9.87	1.75	1.33	.35	.69	.013	4.50

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.70	50.33	.055	8.71

MESABI CHIEF

Location: Itasca county, Minn., Section 23, Township 57, Range 22.

Description: Mine not yet opened up. The ore from this mine will be mixed into the HANNA grade.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.

Manager: E. E. Hunner.

Superintendent: F. H. Cohoe.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

MIDGET MINE

Location: St. Louis county, Minn., Section 34, Township 58, Range 21.
Description: First opened up in 1917, but is now inactive.
Operating Company: G. G. Hartley, Duluth, Minn.
Manager: G. G. Hartley, Duluth, Minn.
Sales Agents: Oglebay, Norton & Co., Cleveland, O.
Yearly Shipments:

1917—113,303 tons	1918—	1919—

Total, tons 113,303

MILLER MINE

Location: St. Louis county, Minn., Section 4, Township 58, Range 15.
Description: This mine was first opened up in 1904. The ore is a soft, brown nonbessemer hematite. The shaft system of mining is used, the greatest vertical depth being 212 feet. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.
Operating Company: Pitt Iron Mining Co., Steubenville, O.
Manager: G. B. LeVan.
Superintendent: C. E. Moore.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

1904—	1910—216,263 tons	1916—252,404 tons
1905—118,520 tons	1911—282,636 tons	1917—312,875 tons
1906—234,071 tons	1912—301,518 tons	1918—329,151 tons
1907—279,453 tons	1913—344,547 tons	1919—310,140 tons
1908—224,321 tons	1914—297,379 tons	
1909—277,119 tons	1915—247,188 tons	

Total, tons 4,027,585

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.74	.079	6.37	.77	2.59	.37	.17	.025	6.47

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.83	50.91	.071	5.65

MINNEWAS MINE

Location: St. Louis county, Minn., Section 16, Township 58, Range 17.
Description: First opened up in 1893, but is now inactive.
Operating Company: Oliver Iron Mining Co., Eveleth, Minn.
Yearly Shipments:

1893— 13,858 tons	1911— 295 tons	1915— 33,478 tons
1894— 2,140 tons	1912—	1916— 11,027 tons
1908— 525 tons	1913—	
1910— 963 tons	1914— 5,798 tons	

Total, tons 68,084

MINORCA MINE

Location: St. Louis county, Minn., Sections 4 and 5, Township 58, Range 17.

Description: First opened up in 1902, but is now idle.

Yearly Shipments:

1902— 35,499 tons	1907—154,661 tons	1912— 37,235 tons
1903—115,886 tons	1908— 80,330 tons	1913— 90,837 tons
1904—121,739 tons	1909—119,154 tons	1914— 85,541 tons
1905—117,653 tons	1910— 6,661 tons	1915—116,591 tons
1906—155,541 tons	1911— 67,942 tons	

Total, tons 1,365,120

MISSABE MOUNTAIN MINE

Location: St. Louis county, Minn., Section 8, Township 58, Range 17.

Description: First opened up in 1893. This mine ships seven grades of ore: GROUPS 2 and 5, medium dark-brown bessemer hematites, GROUPS 3, 4 and 10, soft, medium dark brown nonbessemer hematites, GROUP 7, soft reddish-brown nonbessemer hematites and GROUP 9, soft dark-brown nonbessemer hematite. The mine is worked by the open-pit system, the greatest vertical depth being 185 feet. The ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Virginia, Minn.

General Manager: J. H. McLean.

District Manager: W. J. West, Virginia, Minn.

Yearly Shipments:

1893—125,015 tons	1903— 5,866 tons	1912— 5,592 tons
1894—505,946 tons	1904— 5,395 tons	1913—321,835 tons
1895—111,038 tons	1905— 9,853 tons	1914— 5,347 tons
1896—126,334 tons	1906— 5,674 tons	1915—668,060 tons
1898—139,885 tons	1907—111,208 tons	1916—539,913 tons
1899— 73,479 tons	1908— 6,056 tons	1917— 62,931 tons
1900— 76,871 tons	1909— 7,839 tons	1918—1,173,311 tons
1901— 5,420 tons	1910— 7,226 tons	1919—1,260,153 tons
1902— 5,131 tons	1911— 5,294 tons	

Total, tons 5,468,673

Analysis: See analyses of GROUPS 2, 3, 4, 6, 7, 9 and 10.

MISSISSIPPI MINE

Location: Itasca county, Minn., N. E. ¼ of N. E. ¼ of Section 23, Township 57, Range 22.

Description: First opened up in 1910. This mine ships two grades of ore, a soft, brown, bessemer hematite, and a soft, reddish-brown, nonbessemer hematite. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 133 feet. The ore is shipped via the

Great Northern railway to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Arthur Iron Mining Co.

Yearly Shipments:

1910— 36,581 tons	1913—122,972 tons	1918—188,255 tons
1911—328,601 tons	1914—507,660 tons	1919—105,489 tons
1912—274,729 tons	1917— 99,983 tons	

Total, tons 1,952,508

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.65	.064	10.94	.37	1.29	.19	.16	.011	5.82

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
8.25	51.98	.058	10.04

MOHAWK MINE

Location: St. Louis county, Minn., Section 4, Township 58, Range 15.

Description: First opened up in 1906. The ore is a soft, red nonbessemer hematite. The mine is worked by the underground slicing system, the greatest vertical depth being 305 feet. The ore is shipped via the D. & I. R. railway to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Mohawk Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. C. David.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1906— 92,715 tons	1911—121,822 tons	1916—185,313 tons
1907—128,870 tons	1912—161,539 tons	1917—267,204 tons
1908—119,439 tons	1913—171,849 tons	1918—255,415 tons
1909—216,291 tons	1914— 35,050 tons	1919—162,922 tons
1910—123,180 tons	1915— 69,318 tons	

Total, tons 2,110,927

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.
56.25	.070	9.50	1.00	2.35

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
13.00	48.94	.061	8.27

MONICA MINE

Location: St. Louis county, Minn., Section 9, Township 58, Range 16.

Description: First opened up in 1909, but is now idle.

Yearly Shipments:

1909— 7,614 tons	1912— 92,754 tons	1915— 77,946 tons
1910— 69,503 tons	1913— 62,032 tons	
1911—112,952 tons	1914— 46,922 tons	

Total, tons 469,723

MONROE-TENER MINE

Location: St. Louis county, Minn., Section 28, Township 58, Range 20.

Description: First opened up in 1905. The ore is a soft, brownish nonbessemer. The mine is operated by the open-pit and underground methods. The ore is shipped via the Great Northern railway to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co.

Yearly Shipments:

1905— 71,866 tons	1910—	1915—
1906—485,148 tons	1911—	1916—
1907—347,712 tons	1912—	1917—
1908—174,033 tons	1913—485,847 tons	1918—275,815 tons
1909—403,905 tons	1914—	1919— 13,885 tons

Total, tons 2,258,211

MORRIS MINE

Location: St. Louis county, Minn., Sections 31 and 32, Township 58, Range 20.

Description: First opened up in 1905. This mine ships six grades of ore: GROUP 2, soft, brownish-black bessemer hematite, GROUP 5, soft, gray-black bessemer hematite, GROUP 10, soft, brownish-yellow bessemer hematite, GROUP 3 and 9, soft, yellowish-red nonbessemer hematite, and GROUP 7, soft, brownish-yellow nonbessemer hematite. The mine is worked by the open-pit system. The ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean.

District Manager: M. H. Godfrey, Hibbing, Minn.

Yearly Shipments:

1905—1,070,937 tons	1910—1,364,673 tons	1915—1,167,421 tons
1906—1,809,743 tons	1911— 40,481 tons	1916—1,609,971 tons
1907—2,076,388 tons	1912— 395 tons	1917—1,605,701 tons
1908— 528,154 tons	1913—	1918—1,044,558 tons
1909—1,831,187 tons	1914— 365 tons	1919— 799,047 tons

Total, tons 14,949,021

Analysis: See analyses of GROUPS 2, 3, 5, 7, 9 and 10.

MORROW MINE

Location: St. Louis county, Minn., Section 4, Township 57, Range 17.

Description: First opened up in 1913. This mine ships two ores: MORROW BESSEMER, a soft, red, bessemer hematite and MORROW, a soft, red, nonbessemer hematite. The mine is worked by the underground top-slicing system, the greatest vertical depth being 250 feet. The ore is shipped via the D. & I. R. railway to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Bowe-Burke Mining Co., Cleveland, O.

Manager: W. W. Bowe.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1913—	91,512 tons	1916—		1919—	42,289 tons
1914—		1917—	69,554 tons		
1915—		1918—	94,009 tons		

Total, tons 297,364

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Morrow:

Iron	Phos.	Silica	Mang.	Alum.
57.50	.060	8.70	.95	1.95

The ore in its natural state is as follows:

Morrow:

Moist.	Iron	Phos.	Silica
15.00	48.88	.051	7.40

MORTON MINE

Location: St. Louis county, Minn., Section 11, Township 57, Range 21.

Description: First opened up in 1912. The mine is worked by the underground system. The ore is shipped via the Great Northern railroad to Allouez, Wis., and thence by boat to the lower lake ports.

Sales Agents: The Tod Stambaugh Co., Cleveland, O.

Yearly Shipments:

1912—	5,948 tons	1915—	58,214 tons	1918—	
1913—	29,989 tons	1916—	44,940 tons	1919—	
1914—	339 tons	1917—	1,832 tons		

Total, tons 141,262

MOUNTAIN IRON MINE (Formerly Aetna Mine)

Location: St. Louis county, Minn., Section 3, Township 58, Range 18.

Description: First opened up in 1892, but is now inactive.

Yearly Shipments:

1892— 4,245 tons	1899—1,137,970 tons	1906—2,563,111 tons
1893— 121,463 tons	1900—1,001,324 tons	1907—1,973,519 tons
1894— 573,440 tons	1901—1,058,160 tons	1908— 206,698 tons
1895— 371,274 tons	1902—1,617,772 tons	1909—
1896— 159,744 tons	1903—1,348,714 tons	1910—
1897— 773,538 tons	1904—1,168,855 tons	
1898— 650,955 tons	1905—2,495,089 tons	

Total, tons 17,198,871

MYERS MINE

Location: St. Louis county, Minn., Section 22, Township 58, Range 20.

Description: First opened up in 1905, but is now inactive.

Yearly Shipments:

1905—188,568 tons	1910—131,440 tons	1915—216,129 tons
1906—228,451 tons	1911— 93,203 tons	1916— 58,898 tons
1907—153,770 tons	1912—101,558 tons	1917— 41,971 tons
1908—150,249 tons	1913— 39,951 tons	1918— 12,216 tons
1909—193,698 tons	1914—	1919—

Total, tons 1,610,105

NASSAU MINE

Location: St. Louis county, Minn., Section 5, Township 57, Range 20.

Description: First opened up in 1907. The ore is a soft, red, nonbessemer hematite, and is crushed. The mine is worked by the underground method, the greatest vertical depth being 240 feet. The ore is shipped via the D., M. & N. railway to the D., M. & N. docks at Duluth and the Great Northern railway to the G. N. docks at Allouez, Wis., and thence by boat to lower lake ports.

Operating Company: Leetonia Mining Co., Jones & Laughlin Bldg., Pittsburgh, Pa.

General Superintendent: Mark Elliott.

Yearly Shipments:

1907— 19,172 tons	1909— 11,940 tons	1918— 40,412 tons
1908—	1910— 39 tons	

Total, tons 71,563

NORMAN MINE

Location: St. Louis county, Minn., Section 9, Township 58, Range 17.

Description: First opened up in 1894, but the mine is practically exhausted.

Yearly Shipments:

1894—	39,008	tons	1908—	655,273	tons	1914—	261,062	tons
1895—	93,392	tons	1909—	1,835,611	tons	1915—	250,695	tons
1896—	77,523	tons	1910—	977,937	tons	1916—	320,937	tons
1897—	101,077	tons	1911—	643,294	tons	1917—	128,861	tons
1898—	110,141	tons	1912—	614,002	tons	1918—	70,494	tons
1907—	3,498	tons	1913—	276,732	tons	1919—	22,251	tons

Total, tons 6,481,788

NORTH EDDY MINE

Location: St. Louis county, Minn., Section 11, Township 57, Range 21.

Description: First opened up in 1915. The ore is a nonbessemer hematite. The mine is worked by the underground system. The ore is shipped via the Great Northern railway to Allouez, Wis., and thence by boat to lower lake ports.

Sales Agents: The Tod-Stambaugh Co., Cleveland, O.

Yearly Shipments:

1915—	2,659	tons	1917—	163,774	tons	1919—	72,854	tons
1916—	104,710	tons	1918—	124,649	tons			

Total, tons 468,846

NORTH HARRISON MINE

Location: Itasca county, Minn., E½ of SW¼, of Section 31, Township 57, Range 22.

Description: First opened up in 1915. This mine ships four grades of ore: SMITH and CONNOLLY, soft, red bessemer hematites, and CONNOLLY and KIPP, soft, red nonbessemer hematites. The mine is worked by the open-pit and steam-shovel systems, the greatest vertical depth being 100 feet. The ore is shipped via the Great Northern railroad to the G. N. docks, at Allouez, Wis., and thence by boat to the lower lake ports.

Operating Company: Butler Bros., St. Paul, Minn.

President: Walter Butler.

Superintendent: A. J. Connolly.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1915—	169,967	tons	1917—	344,694	tons	1919—	527,857	tons
1916—	417,094	tons	1918—	377,015	tons			

Total, tons 1,836,627

Analysis: See analyses of SMITH and CONNOLLY grades.

NORTH STAR MINE

Location: Itasca county, Minn., Section 21, Township 56, Range 24.

Description: This mine has not yet been opened up.

Operating Company: The Mesaba-Cliffs Iron Mining Co., Taconite, Minn.

Manager: M. M. Duncan.

Superintendent: M. H. Barber.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

NORTH UNO MINE G. N.

Location: St. Louis county, Minn., N. ½ of S. W. ¼ Section 2, Township 57, Range 21.

Description: First opened up in 1910. This mine ships two grades of ore, a soft, brownish-black bessemer hematite, and a soft yellowish-brown nonbessemer hematite. The ore is not crushed. The mine is worked by the underground methods. The ore is shipped by the Great Northern railway to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.

Manager: E. E. Hunner.

Superintendent: F. H. Cohoe.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1910—341,939 tons	1914— 90,088 tons	1918— 82,954 tons
1911—479,315 tons	1915—	1919— 67,587 tons
1912—545,033 tons	1916— 70,588 tons	
1913—381,632 tons	1917—177,027 tons	

Total, tons 2,236,154

Analysis: See analysis of HANNA grade.

N. P. NORTH UNO MINE

Location: St. Louis county, Minn., NW¼ of SW¼ of Section 2, Township 57, Range 21.

Description: First opened up in 1918. This mine ships two grades of ore, SMITH, a soft, red bessemer hematite and CONNOLLY, a soft, red nonbessemer hematite. The mine is worked by the open-pit and steam-shovel systems, the greatest vertical depth being 75 feet. The ore is shipped via the Great Northern railroad to Allouez, Wis., and thence by boat to the lower lake ports.

Operating Company: Butler Bros., St. Paul, Minn.

President: Walter Butler.

Superintendent: Emmett Butler.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1918— 6,433 tons	1919— 17,017 tons

Total, tons 23,450

Analysis: See analyses of SMITH and CONNOLLY grades.

OHIO MINE

Location: St. Louis county, Minn., Section 9, Township 58, Range 17.

Description: First opened up in 1895, but is now inactive.

Yearly Shipments:

1895— 28,943 tons	1901—	1907—801,410 tons
1896— 69,925 tons	1902—	1914—
1897— 52,957 tons	1903—	1915—
1898—101,607 tons	1904—	1916— 23,665 tons
1899—287,082 tons	1905—346,304 tons	
1900—172,597 tons	1906—	

Total, tons 1,884,490

ONONDAGA MINE

Location: St. Louis county, Minn., Section 4, Township 58, Range 17.

Description: First opened up in 1907, but the mine is now idle.

Yearly Shipments:

1907— 521 tons	1910— 61,935 tons	1913— 6,847 tons
1908— 30,887 tons	1911— 63,798 tons	
1909— 59,389 tons	1912—	

Total, tons 223,377

ORDEAN MINE

Location: St. Louis county, Minn., Sections 31 and 32, Township 59, Range 17.

Description: First opened up in 1916, but the mine is now exhausted.

Yearly Shipments:

1916—395,591 tons	1918—100,517 tons
1917—383,968 tons	1919— 85,838 tons

Total, tons 965,914

PATRICK MINE

Location: Itasca county, Minn., Section 2, Township 56, Range 23.

Description: First opened up in 1917. This mine ships two grades of ore: SMITH, a soft, red bessemer hematite, and CONNOLLY, a soft, red nonbessemer hematite. The mine is worked by the open-pit and steam-shovel systems, the greatest vertical depth being 75 feet. The ore is shipped via the Great Northern railroad to the G. N. docks at Allouez, Wis., and thence by boat to the lower lake ports.

Operating Company: Butler Bros., St. Paul, Minn.

President: Walter Butler.

Superintendent: A. J. Connolly.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1917— 95,994 tons	1918—237,159 tons	1919—287,038 tons

Total, tons 620,191

Analysis: See analyses of SMITH and CONNOLLY grades.

PEARCE MINE

Location: St. Louis county, Minn., N. E. ¼ of N. W. ¼ of Section 28, Township 58, Range 20.

Description: First opened up in 1902, but the mine is now abandoned.

Yearly Shipments:

1902— 54,884 tons	1906— 65,682 tons	1910— 60,411 tons
1903— 50,204 tons	1907— 71,645 tons	1911— 35,343 tons
1904— 235 tons	1908—	1912—
1905—	1909—	1913—123,948 tons

Total, tons 462,532

PEARSON MINE

Location: Itasca county, Minn., Section 29, Township 57, Range 22.

Description: First opened up in 1909. The ore is a soft, brown bessemer hematite. The mine was operated by caving and slicing system. In 1917 a washing plant with a capacity of 250,000 tons was constructed by the Allis-Chalmers Manufacturing Co. The plant is fed both from skip-hoist and belt conveyor from outside. Ore is shipped via the Great Northern railroad to Allouez Bay, and thence by boat to the lower lake ports.

Operating Company: Clement K. Quinn & Co., Duluth, Minn.

Yearly Shipments:

1909— 68,683 tons	1912— 75,969 tons	1915—
1910— 78,133 tons	1913—104,180 tons	1916—
1911— 75,696 tons	1914—	

1918—67,794 tons concentrates
1917— 9,433 tons concentrates
1919—

Total, tons 479,898

PERKINS MINE

Location: St. Louis county, Minn., Section 26, Township 59, Range 15.

Description: First opened up in 1909, but is now idle.

Operating Company: Perkins Mining Co., 811 Sellwood Bldg., Duluth, Minn.

Manager: R. M. Sellwood.

Superintendent: Wm. Mudge, Jr.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1909— 59,029 tons	1913—120,012 tons	1917— 80,942 tons
1910— 80.622 tons	1914— 18,182 tons	1918— 50,807 tons
1911— 44,933 tons	1915—	1919— 18,559 tons
1912— 60,523 tons	1916— 79,281 tons	

Total, tons 612,890

PENOBSCOT MINE

Location: St. Louis county, Minn., Section 1, Township 57, Range 21.

Description: First opened up in 1897. This mine ships three grades of ore: GROUPS 2, 3 and 9. The ore is shipped via the D. M. & N. railroad to Duluth, and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean.

District Manager: M. H. Godfrey, Hibbing, Minn.

Yearly Shipments:

1897— 11,933 tons	1901—221,080 tons	1918— 519 tons
1898— 29,652 tons	1902—209,531 tons	1919— 32,531 tons
1899— 85,619 tons	1903— 1,615 tons	
1900—146,641 tons	1911— 189 tons	

Total, tons 739,310

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Group 2:

Iron	Phos.	Silica	Mang.
61.67	.049	4.90	.57

Group 3:

58.96	.082	6.09	.75

Group 9:

56.71	.079	6.67	2.05

The ore in its natural state is as follows:

Group 2:

Moist.	Iron	Phos.	Silica
11.51	54.57	.043	4.34

Group 3:

13.37	51.08	.071	5.28

Group 9:

13.42	49.10	.069	5.78

PETTIT MINE

Location: St. Louis county, Minn., Section 25, Township 58, Range 17.

Description: First opened up in 1902. The ore is a soft, red nonbessemer hematite. The mine is worked by the slicing system, the greatest vertical depth being 302 feet. The ore is shipped via the Duluth & Iron Range railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, O.

Manager: F. J. Webb.

Superintendent: W. M. Webb.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1902— 17,278 tons	1908— 57,140 tons	1914—120,868 tons
1903— 52,706 tons	1909— 83.548 tons	1915—158,397 tons
1904— 27,088 tons	1910— 62,456 tons	1916—178,917 tons
1905—140,239 tons	1911—129,776 tons	1917—192,920 tons
1906— 82,757 tons	1912—157,208 tons	1918—258,174 tons
1907— 36,074 tons	1913—131,864 tons	1919—214,467 tons

Total, tons 2,101,877

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.00	.070	9.25	1.00	3.26	.26	.19	.011	5.26

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
13.00	48.72	.061	8.05

PHILBIN MINE

Location: St. Louis county, Minn., Section 6, Township 57, Range 20.

Description: First opened up in 1914. This mnie ships five grades of ore: GROUP 2, soft, reddish-brown bessemer hematite, GROUP 7, soft, reddish-brown nonbessemer hematite, also GROUPS 3, 5 and 9. The mine is worked by the underground system, the greatest vertical depth being 221 feet. The ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean.

District Manager: M. H. Godfrey, Hibbing, Minn.

Yearly Shipments:

1915— 9,842 tons	1917—204,510 tons	1919—142,195 tons
1916—110,922 tons	1918—233,484 tons	

Total, tons 700,953

Analysis: See analyses of GROUPS 2, 3, 5, 7, and 9.

PILLSBURY MINE

Location: St. Louis county, Minn., Section 29, Township 58, Range 20.

Description: First opened up in 1898, but is now inactive.

Yearly Shipments:

1898— 99,691 tons	1902—238,122 tons	1906— 33,546 tons
1899—106,487 tons	1903—229,133 tons	1907—489,718 tons
1900—101,032 tons	1904—	1908— 59,889 tons
1901—120,723 tons	1905—161,924 tons	

Total, tons 1,640,265

PILOT MINE

Location: St. Louis county, Minn., N. W.¼, S. E.¼ of Section 2, Township 58, Range 18.

Description: First opened up in 1917. The ore, HANNA, is a soft, brown nonbessemer hematite. The mine is worked by the open-pit and underground methods, the greatest vertical depth being 70 feet. The ore is shipped via the Great Northern railroad to Allouez, Superior, and thence by boat to the lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.

Manager: E. E. Hunner.

Superintendent: F. H. Cohoe.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1917—	1918—	1919— 80,814 tons

Total, tons 80,814

Analysis: See analysis of HANNA grade.

PRINDLE MINE

Location: St. Louis county, Minn., Section 36, Township 59, Range 18.

Description: First opened up in 1914, but is now inactive.

Yearly Shipments:

1914— 12,392 tons	1915— 24,100 tons	1916— 10,995 tons

Total, tons 47,487

QUINN MINE

Location: Itasca county, Minn., SW¼ of SW¼ Section 31, Township 57, Range 22.

Description: First opened up in 1913. This mine ships two grades of ore: COOLEY, a bessemer hematite, and KIPP, a nonbessemer hematite. Both are concentrates from washing plant. The mine is worked by the open-pit and steam-shovel systems, the greatest vertical depth being 80 feet. The ore is shipped via the Great Northern railroad to the G. N. docks at Allouez, Wis., and thence by boat to the lower lake ports.

Operating Company: Butler Bros., St. Paul, Minn.

President: Walter Butler.

Superintendent: A. J. Connolly.

Yearly Shipments:

1913—	1916—217,619 tons	1919— 17,156 tons
1914— 49,251 tons	1917— 44,721 tons	
1915— 91,007 tons	1918— 59,019 tons	

Total, tons 478,773

Analysis: See analyses of KIPP and COOLEY ores.

SAUNTRY-ALPENA MINE

Location: St. Louis county, Minn., Section 5, Township 58, Range 17.

Description: First opened up in 1899. This mine ships eight grades of ore: GROUPS 2, 5 and 10, soft, reddish-brown bessemer hematites, GROUPS 3, 4, 7 and 9, and Alpena, soft, reddish-brown nonbessemer hematites. The mine is worked by the underground, open-pit and milling methods, the greatest vertical depth being 286 feet. The ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Virginia, Minn.

General Manager: J. H. McLean.

District Manager: W. J. West, Virginia, Minn.

Yearly Shipments:

1898— 53,004 tons	1911—1,057,819 tons	1916— 933,937 tons
1899— 68,560 tons	1912—1,025,301 tons	1917— 596,049 tons
1900— 328,739 tons	1913—1,705,131 tons	1918— 531,427 tons
1901— 249,837 tons	1914—1,131,255 tons	1919— 422,825 tons
1910— 242,373 tons	1915—1,455,825 tons	

Total, tons 9,802,082

Analysis: See analyses of GROUPS 2, 3, 4, 5, 7, 9 and 10 and ALPENA.

SCHLEY MINE

Location: St. Louis county, Minn., Section 25, Township 58, Range 17.

Description: First opened up in 1910. The ore is a soft, red bessemer and nonbessemer hematite. The mine is worked by the slicing system, the greatest vertical depth being 274 feet. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, O.

Manager: F. J. Webb.

Superintendent: W. M. Webb.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1910— 13,369 tons	1914— 16,386 tons	1918—
1911—120,365 tons	1915—101,891 tons	1919—
1912—159,126 tons	1916— 78,093 tons	
1913—202,477 tons	1917— 777 tons	

Total, tons 692,484

SCRANTON MINE (Formerly Elizabeth Mine)

Location: St. Louis county, Minn., Section 12, Township 57, Range 21.

Description: First opened up in 1904. The ore is a soft, red nonbessemer hematite. The mine was worked by the underground slicing method, but is now being stripped for open-

pit mining, the greatest vertical depth being 135 feet. The ore is shipped via the Great Northern and the D. M. & N. railroads to Superior, Wis., and Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Hoyt Mining Co., Cleveland, Ohio.
Assistant General Manager: W. P. Chinn.
General Superintendent: Robert Murray.
Sales Agents: Pickands, Mather & Co., Cleveland, O.
Yearly Shipments:

1904—	1,168 tons	1908—		1912—	254,500 tons
1905—		1909—		1913—	227,270 tons
1906—		1910—		1914—	20,205 tons
1907—		1911—		1915—	18,698 tons

Total, tons 521,841

SECTION 17 MINE

Location: St. Louis county, Minn., Section 17, Township 58, Range 19.
Description: First opened up in 1912, but is not now in operation.
Yearly Shipments:

1912—	4,203 tons	1913—	16,646 tons

Total, tons 20,849

SELLERS MINE

Location: St. Louis county, Minn., Section 6, Township 57, Range 20.
Description: First opened up in 1895. This mine ships six grades of ore: GROUP 2, soft, brownish-black bessemer hematite, GROUP 5, soft, grayish-black bessemer hematite, GROUP 10, soft, yellowish-red bessemer hematite, GROUP 7, soft, yellowish-red nonbessemer hematite, GROUP 3 and 9, soft, brownish-yellow nonbessemer hematites. The mine is worked by the open-pit system. The ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.
Operating Company: Oliver Iron Mining Co., Hibbing, Minn.
General Manager: J. H. McLean.
District Manager: M. H. Godfrey, Hibbing, Minn.
Yearly Shipments:

1895—	47,433 tons	1904—	207,990 tons	1913—	268,070 tons
1896—	153,037 tons	1905—	261,501 tons	1914—	
1897—		1906—	241,031 tons	1915—	721,908 tons
1898—	112,765 tons	1907—	155,060 tons	1916—	1,344,121 tons
1899—	174,867 tons	1908—	354,780 tons	1917—	1,575,057 tons
1900—	56,280 tons	1909—	626,169 tons	1918—	865,070 tons
1901—	34,918 tons	1910—	954,042 tons	1919—	265,925 tons
1902—	193,428 tons	1911—	87,275 tons		
1903—	251,631 tons	1912—			

Total tons 8,952,358

Analysis: See analyses of GROUPS 2, 3, 5, 7, 9 and 10.

SMITH MINE

Location: St. Louis county, Minn., SW¼ of NW¼ of Section 2, Township 57, Range 21.

Description: First opened up in 1917. This mine ships two grades of ore: SMITH, a soft, red bessemer hematite, and CONNOLLY, a soft, red nonbessemer hematite. The mine is worked by the open-pit and steam-shovel systems, the greatest vertical depth being 75 feet. The ore is shipped via the Great Northern railroad to the G. N. docks, at Allouez, Wis., and thence by boat to lower lake ports.

Operating Company: Butler Bros., St. Paul, Minn.

President: Walter Butler.

Superintendent: Emmett Butler.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1917—249,417 tons 1918— 39,292 tons 1919— 74,389 tons

Total, tons 363,098

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Smith:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
61.20	.038	8.50	.38	.82	.50	.38	.035	1.81

Connolly:

58.60	.062	8.48	.72	1.66	.12	.10	.010	4.44

The ore in its natural state is as follows:

Smith:

Moist.	Iron	Phos.	Silica
7.72	56.48	.035	7.84

Connolly:

Moist.	Iron	Phos.	Silica
10.48	52.46	.056	7.59

SHADA No. 1 MINE

Location: Itasca county, Minn., Section 29, Township 57, Range 22.

Description: First opened up in 1909. The ore is a soft, brown bessemer hematite, mined by underground caving and slicing system. The property was idle for three years, and in 1917 was equipped with a modern washing plant. The product is a washed ore, and is shipped via the Great Northern railroad to the G. N. docks at Allouez, Wis., and thence by boat to lower lake ports.

Operating Company: Shada Mining Co., Alworth building, Duluth, Minn.

Manager: Clement K. Quinn.

General Superintendent: Edward P. Scallon.

Sales Agents: Clement K. Quinn & Co., Alworth building, Duluth, Minn., and Cleveland, O.

Analysis: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.05	.041	8.12	.75	.67	.21	.23	.006	4.84

SHADA No. 2 MINE

Location: Itasca county, Minn., Section 2, Township 56 N, Range 23 W.

Description: First opened up in 1920. The ore is a soft, red bessemer hematite, is concentrated at the mine and shipped as a washed ore. The mine is worked by the open-pit, steam-shovel method. The ore is shipped via the Great Northern railroad to the G. N. docks at Allouez, Wis., and thence by boat to lower lake ports.

Operating Company: Shada Mining Co., Alworth building, Duluth, Minn.

Manager: Clement K. Quinn.

General Superintendent: Edward P. Scallon.

Sales Agents: Clement K. Quinn & Co., Alworth building, Duluth, Minn., and Cleveland, O.

Analysis: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.35	.040	8.00	.30	.70	.20	.20	.017	4.80

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
9.00	54.01	.036	7.28

SHARON MINE

Location: St. Louis county, Minn., Section 20, Township 58, Range 19.

Description: First opened up in 1901, but the mine is now inactive. The ore was a nonbessemer hematite.

Yearly Shipments:

1901— 56,810 tons 1902—224,526 tons 1903— 48,199 tons

Total, tons 329,535

SHENANGO MINE

Location: St. Louis county, Minn., Sections 22, 23 and 27, Township 58, Range 20.

Description: First opened up in 1904. This mine ships two ores: SHENANGO, a soft, brown bessemer hematite, and WILPEN, a soft, brown nonbessemer hematite. The mine is worked by the open-pit and underground methods, the greatest vertical depth being 300 feet. The ore is shipped via the D. M. & N. railroad to the D. M. & N. docks at Duluth, Minn., and thence by boat to lower lake ports.

Operating Company: The Shenango Furnace Co., Pittsburgh, Pa
Manager: E. J. Maney.
Yearly Shipments:

1904— 51,712 tons	1910—965,148 tons	1916—979,658 tons
1905—213,097 tons	1911—732,978 tons	1917—680,258 tons
1906—383,717 tons	1912—805,413 tons	1918—525,301 tons
1907—387,093 tons	1913—794,911 tons	1919—268,309 tons
1908—461,887 tons	1914—546,519 tons	
1909—805,751 tons	1915—939,674 tons	

Total, tons 9,541,426

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Shenango:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.21	.046	5.38	1.19	1.76	.20	.17	.004	5.40

Wilpen:

56.96	.066	7.97	1.19	2.46	.28	.18	....	5.80

The ore in its natural state is as follows:

Shenango:

Moist.	Iron	Phos.	Silica
11.60	53.23	.041	4.75

Wilpen:

12.12	50.06	.058	7.00

SHIRAS MINE

Location: St. Louis county, Minn., Section 16, Township 58, Range 19.

Description: First opened up in 1914. This mine ships four grades of ore: GROUPS 2 and 5, soft, reddish-brown bessemer hematites; GROUPS 3 and 7, soft, reddish-brown nonbessemer hematites. The mine is worked by the underground system, the greatest vertical depth being 158 feet. The ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Buhl, Minn.
General Manager: J. H. McLean.
District Manager: W. J. West, Virginia, Minn.
Yearly Shipments:

1914— 5,206 tons	1916—172,518 tons	1918—125,549 tons
1915— 50,707 tons	1917—191,042 tons	1919— 74,484 tons

Total, tons 619,506

Analysis: See analyses of GROUPS 2, 3, 5 and 7.

SOUTH LONGYEAR MINE

Location: St. Louis county, Minn., Section 6, Township 57, Range 20.

Description: The mine is about to be opened. Two ores will be shipped, a soft, brown, bessemer hematite, and a soft, brown, nonbessemer hematite. The ore will be shipped via the

Great Northern railway to the G. N. docks at Allouez, Wis., and thence by boat to lower lake ports.

Operating Company: Inter-State Iron Co., Jones & Laughlin Bldg., Pittsburgh, Pa.

General Superintendent: Mark Elliott, Virginia, Minn.

SOUTH UNO MINE G. N.

Location: St. Louis county, Minn., S. ½ of S. W. ¼ Section 2, Township 57, Range 21.

Description: First opened up in 1910. This mine ships a soft, brown, nonbessemer ore. The ore is not crushed. The mine is operated by the open-pit method. The ore is shipped via the Great Northern railway to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.

Manager: Earl E. Hunner.

General Superintendent: F. H. Cohoe.

Yearly Shipments:

1911— 266,390 tons	1914— 945,840 tons	1917— 99,992 tons
1912—1,305,216 tons	1915— 21,557 tons	1918— 130,483 tons
1913—1,202,341 tons	1916—	1919— 87,371 tons

Total, tons 4,059,190

Analysis: See HANNA grade.

SPRING MINE

Location: St. Louis county, Minn., Section 11, Township 59, Range 14.

Description: First opened up in 1906, but is now idle.

Yearly Shipments:

1907— 15,257 tons	1909—
1908— 20,516 tons	1910— 31,909 tons

Total, tons 67,682

SPRUCE MINE

Location: St. Louis county, Minn., Section 31, Township 58, Range 17.

Description: First opened up in 1894. This mine ships three grades of ore: GROUP 1, a soft, brown bessemer hematite, GROUPS 4 and 5, soft, brown nonbessemer hematites. The mine is worked by the underground methods, the greatest vertical depth being 281 feet. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Eveleth, Minn.

General Manager: J. H. McLean.

District Manager: W. J. West, Virginia, Minn.

Yearly Shipments:

1894— 5,628 tons	1903—587,153 tons	1912—740,801 tons
1895— 47,700 tons	1904—589,319 tons	1913—544,876 tons
1896— 96,280 tons	1905—606,295 tons	1914—488,870 tons
1897— 12,215 tons	1906—674,602 tons	1915—638,230 tons
1898—	1907—610,457 tons	1916—463,179 tons
1899— 1,621 tons	1908—430,633 tons	1917—352,563 tons
1900—101,675 tons	1909—579,903 tons	1918—562,116 tons
1901—279,515 tons	1910—613,947 tons	1919—973,218 tons
1902—543,203 tons	1911—638,180 tons	

Total, tons 11,182,179

Analysis: See analyses of GROUPS 1, 4 and 5.

ST. CLAIR MINE

Location: St. Louis county, Minn., Section 23, Township 58, Range 20.

Description: First opened up in 1900, but is now inactive.

Yearly Shipments:

1903— 6,148 tons	1904— 26,748 tons	1905— 61,792 tons

Total, tons 94,688

STEPHENS MINE

Location: St. Louis county, Minn., Sections 23, 25 and 26, Township 59, Range 15.

Description: First opened up in 1903. The ore was nonbessemer hematite. The mine was operated by the Oliver Iron Mining Co., but is now inactive.

Yearly Shipments:

1903— 87,055 tons	1904—	1905—367,764 tons

Total, tons 454,819

STEVENSON MINE

Location: St. Louis county, Minn., Sections 7 and 8, Township 57, Range 21.

Description: First opened up in 1900. The ore, STEVENSON, is a soft blue bessemer hematite. Open-pit system of mining is used. The ore is shipped via the Great Northern railroad to Allouez, Wis., and from there by boat to the lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1900— 56,031 tons	1907—1,142,977 tons	1914— 89,899 tons
1901— 666,273 tons	1908— 516,770 tons	1915— 8,585 tons
1902—1,434,681 tons	1909—1,030,742 tons	1916— 349,960 tons
1903—1,014,582 tons	1910— 953,079 tons	1917— 344,872 tons
1904—1,652,021 tons	1911— 500,323 tons	1918— 323,907 tons
1905—1,428,614 tons	1912— 682,514 tons	1919— 73,416 tons
1906—1,041,500 tons	1913— 634,656 tons	

Total, tons 13,945,402

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.00	.044	7.43	.71	.93	.43	.46	.006	4.84

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
9.50	54.30	.040	6.72

SUSQUEHANNA MINE

Location: St. Louis county, Minn., Section 6, Township 57, Range 20.

Description: First opened up in 1906. This mine ships three grades of ore: SUSQUEHANNA and SENECA, soft, red nonbessemer hematites, and CARSON, a soft, red bessemer hematite. The mine is worked by the stripping method, the greatest vertical depth being 190 feet. The ore is shipped via the Great Northern railroad to the G. N. docks at Superior, and the D., M. & N. railroad to the D., M. & N. docks at Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: Rogers, Brown Iron Co., Buffalo, N. Y.

Manager: W. C. Agnew.

Yearly Shipments:

1906— 20,984 tons	1911—147,741 tons	1916—764,249 tons
1907—137,207 tons	1912—583,910 tons	1917—609,198 tons
1908—182,352 tons	1913—904,019 tons	1918—569,630 tons
1909—243,049 tons	1914—906,913 tons	1919—459,749 tons
1910—176,869 tons	1915—618,488 tons	

Total, tons 6,324,358

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Seneca:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.94	.081	7.97	1.68	3.19	.19	.14	.007	5.15

The ore in its natural state is as follows:

Seneca:

Moist.	Iron	Phos.	Silica
16.02	47.82	.068	6.69

ST. JAMES MINE

Location: St. Louis county, Minn., Section 3, Township 58, Range 15.

Description: First opened up in 1906. The ore is a soft, blue nonbessemer hematite. The underground system of mining is used. The ore is shipped via the D. & I. R. railroad to Two Harbors, Minn.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1915—	1917—184,885 tons	1919— 78,704 tons
1916— 36,066 tons	1918—242,301 tons	

Total, tons 541,956

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.91	.075	7.93	.59	2.71	.34	.23	.009	4.92

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.64	51.18	.066	7.01

ST. PAUL MINE

Location: Itasca county, Minn., Section 24, Township 57, Range 22.

Description: First opened up in 1905. The ore is a soft, blue, nonbessemer hematite. Open-pit system of mining is used. The ore is shipped via the Great Northern railroad to Allouez Bay, and from there by boat to the lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1906— 24,230 tons	1912— 42,597 tons	1919— 450 tons
1907—113,200 tons	1913— 1,375 tons	

Total, tons 181,852

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.75	.060	8.60	.65	3.61	.35	.40	.007	4.55

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.90	50.88	.053	7.58

SWEENEY MINE

Location: St. Louis county, Minn., Sections 3 and 4, Township 57, Range 21.

Description: First opened up in 1908, but the mine is now inactive, except as to stripping, preparatory to mining.

Yearly Shipments:

1908— 7,579 tons	1910— 769 tons

Total, tons ..... 8,348 tons

THORNE MINE

Location: St. Louis county, Minn., S.E. N. W.¼ and N.E.S.E.¼ of Sec. 17, Township 59, Range 19.

Description: First opened up in 1914. The ore, HANNA, is a soft, brown nonbessemer hematite. The mine is worked by the underground mining method, the greatest vertical depth being 95 feet. The ore is shipped via the Great Northern railroad to the Allouez docks, Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.

Manager: E. E. Hunner .

Superintendent: F. H. Cohoe.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1915— 18,236 tons	1917— 75,024 tons	1919— 99,151 tons
1916— 81,691 tons	1918— 45,033 tons	

Total, tons 319,135

Analysis: See analysis of HANNA grade.

TIOGA MINE

Location: St. Louis county, Minn., Section 28, Township 58, Range 20.

Description: First opened up in 1916. The ore is a soft, brown bessemer and nonbessemer hematite. The mine is worked by the underground method, the greatest vertical depth being 200 feet. The ore is shipped via the D., M. & N. railroad to the D., M. & N. docks at Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: The Shenango Furnace Co., Pittsburgh, Pa.

Manager: E. J. Maney.

Yearly Shipments:

1916— 4,275 tons	1918— 62,678 tons
1917— 80,758 tons	1919—112,155 tons

Total, tons 259,866

Analysis: The average of all cargo analyses for 1919 is as follows:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.95	.044	12.50	.62	1.75	.20	.17	.004	5.40

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
12.20	50.00	.039	10.97

TROY MINE

Location: St. Louis county, Minn., Section 7, Township 57, Range 17.

Description: First opened up in 1903, but is now idle.

Operating Company: Crete Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. C. David.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1903— 15,090 tons	1908— 40,283 tons	1913— 70,748 tons
1904— 12,759 tons	1909— 86,520 tons	1914—
1905— 87,584 tons	1910—104,057 tons	1915—
1906—146,849 tons	1911—	1916— 6,631 tons
1907—100,730 tons	1912—	

Total, tons 671,260

UNION MINE

Location: St. Louis county, Minn., Section 9, Township 58, Range 17.

Description: First opened up in 1900. This mine ships two grades of ore: UNION and OXFORD No. 2, both soft, red and blue bessemer and nonbessemer hematites. The mine is worked by the steam-shovel system, the greatest vertical depth being 175 feet. The ore is shipped via the Duluth & Iron Range railroad to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Union Ore Co., Youngstown, O.

Manager: F. J. Webb.

Superintendent: Wm. White.

Sales Agents: Oglebay, Norton & Co., Cleveland, O.

Yearly Shipments:

1900— 8,297 tons	1907— 61,825 tons	1914—244,436 tons
1901— 93,109 tons	1908— 20,937 tons	1915—247,504 tons
1902—103,522 tons	1909—	1916—241,991 tons
1903— 91,496 tons	1910—	1917—229,380 tons
1904—	1911—	1918—224,973 tons
1905—	1912—213,829 tons	1919—191,557 tons
1906— 20,691 tons	1913—286,934 tons	

Total, tons 2,280,481

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Union:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.50	.042	9.00	.75	2.22	.18	.20	.013	2.56

Oxford:

56.00	.070	7.00	1.50	2.28	.21	.24	.010	7.67

The ore in its natural state is as follows:

Union:

Moist.	Iron	Phos.	Silica
6.50	55.63	.039	8.42

Oxford:

11.00	49.84	.063	6.23

UTICA MINE

Location: St. Louis county, Minn., Sections 2 and 11, Township 57, Range 21.

Description: First opened up in 1902. This mine ships three grades of ore: ALBANY, a soft, yellow, nonbessemer hematite; ALBANY REX, a soft red or yellow nonbessemer hematite, and CRETE, a soft, red, bessemer hematite. The mine is worked by the underground slicing system, the greatest vertical depth being 240 feet. The ore is shipped via the Great Northern railway to the G. N. docks at Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Crete Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: Robert Murray.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1902— 9,009 tons	1908— 57,194 tons	1914—247,714 tons
1903—156,180 tons	1909—201,480 tons	1915—358,652 tons
1904—120,697 tons	1910—232,582 tons	1916—326,360 tons
1905—185,944 tons	1911—100,123 tons	1917—245,314 tons
1906—268,281 tons	1912—223,006 tons	1918—282,854 tons
1907—304,864 tons	1913—352,932 tons	1919—326,338 tons

Total, tons 3,999,524

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Albany:

Iron	Phos.	Silica	Mang.	Alum.
57.50	.078	9.11	1.16	3.21

Crete:

58.46	.057	5.87	.50	1.12

The ore in its natural state is as follows:

Albany:

Moist.	Iron	Phos.	Silica
13.55	49.71	.067	7.87

Crete:

12.10	51.39	.050	5.16

VICTORIA MINE

Location: St. Louis county, Minn., Section 9, Township 58, Range 17.

Description: First opened up in 1906. The ore is a soft, red nonbessemer hematite. The mine is worked by the slicing system, the greatest vertical depth being 170 feet. The ore is shipped via the Duluth & Iron Range railroad to Two Harbors, Minn., and thence by boat to the lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, O.

Manager: F. J. Webb.

Superintendent: Wm. White.

Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

1906— 64,820 tons	1911— 43,557 tons	1916— 71,614 tons
1907— 90,090 tons	1912—	1917— 71,597 tons
1908— 21,310 tons	1913—	1918— 72,478 tons
1909—113,305 tons	1914—	1919— 60,937 tons
1910— 27,592 tons	1915—	

Total, tons 637,000

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.76	.055	12.45	1.36	2.45	.20	.30	.020	2.50

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
8.28	51.11	.050	11.42

VIRGINIA MINE

Location: St. Louis county, Minn., Section 30, Township 58, Range 17.
Description: First opened up in 1893, but is now idle.
Yearly Shipments:

1910—299,046 tons	1912—200,182 tons	1914— 31,233 tons
1911— 97,667 tons	1913—391,109 tons	

Total, tons 1,019,237

VIRGINIA SLIVER MINE

Location: St. Louis country, Minn., Sections 4, 5 and 6, Township 58½, Range 17.
Description: First opened up in 1908. This mine ships three ores: DOVER, a soft, red nonbessemer hematite, WELLINGTON, a soft red nonbessemer hematite, and SLIVER MANGANESE, a soft, red nonbessemer manganiferous hematite. The mine is worked by the open-pit system, the greatest vertical depth being 150 feet. The ore is shipped via the D., M. & N. railroad to Duluth, Minn., and thence by boat to lower lake ports.
Operating Company: Virginia Ore Mining Co., Virginia, Minn.
Manager: E. E. Hunner.
General Superintendent: C. E. Hendrick.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

1908— 49,291 tons	1912—378,541 tons	1916—
1909—256,073 tons	1913—298,006 tons	1917—
1910—358,432 tons	1914—197,041 tons	1918—119,023 tons
1911—167,225 tons	1915—	1919— 20,064 tons

Total, tons 1,843,696

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Sliver Manganese:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
51.90	.045	10.67	3.72	1.62	.31	.22	.010	7.81

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.26	46.58	.040	9.57

VIVIAN MINE

Location: St. Louis county, Minn., Section 20, Township 59, Range 14.

Description: First opened up in 1912, but is now inactive.

Yearly Shipments:

1913— 9,093 tons	1914— 14,993 tons	1915— 49,456 tons

Total, tons 73,542

WABIGON MINE

Location: St. Louis county, Minn., SE¼ of SE¼ of Section 17, Township 58, Range 19.

Description: First opened up in 1920. The ore will be mixed into the Hanna Grade. It is a soft, brown nonbessemer hematite. The mine is now being stripped and will be operated by open-pit, steam-shovel and milling processes. The ore is shipped via the Great Northern railroad to the Allouez docks, Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Hanna Ore Mining Co., Hibbing, Minn.

Manager: E. E. Hunner.

Superintendent: F. H. Cohoe.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Analysis: See analysis of HANNA ore.

WACOOTAH MINE

Location: St. Louis county, Minn., Sections 3 and 11, Township 58, Range 18.

Description: First opened up in 1906. The ore is a soft, brown nonbessemer hematite. The stripping system of mining is used, the greatest vertical depth being 200 feet. The ore is shipped via the D. M. & N. railroad to Duluth, and thence by boat to lower lake ports.

Operating Company: Pitt Iron Mining Co., Steubenville, O.

Manager: G. B. LeVan.

Superintendent: C. E. Moore.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1906— 6,766 tons	1911— 7,805 tons	1916—101,970 tons
1907—158,692 tons	1912—129,073 tons	1917— 73,908 tons
1908—	1913— 43,549 tons	1918—174,342 tons
1909— 60,966 tons	1914— 36,839 tons	1919— 86,326 tons
1910— 35,498 tons	1915— 55,645 tons	

Total, tons 971,379

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.65	.064	5.70	.86	5.46	.28	.13	.119	5.89

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
12.70	49.46	.056	4.98

WADE MINE

Location: St. Louis county, Minn., Sections 12 and 13, Township 58, Range 19.

Description: First opened up in 1918. The ore is a soft, dark-brown nonbessemer hematite, and is partially crushed. The mine is worked by the open-pit and caving methods, the greatest vertical depth being 187 feet. The ore is shipped via the Great Northern railroad to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: M. H. Barber.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1918— 67,577 tons 1919—211,888 tons

Total, tons 278,465

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.00	.064	6.34	.94	1.96	.73	.29	.011	5.18

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
12.50	51.62	.056	5.55

WANLESS MINE

Location: St. Louis county, Minn., Section 16, Township 58, Range 19.

Description: First opened up in 1914. This mine ships five grades of ore: GROUPS 2, 3, 4, 7 and 9. The mine is worked by the underground system, the greatest vertical depth being 179 feet. The ore is shipped via the D. M. & N. railroad to Duluth, Minn., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Buhl, Minn.

General Manager: J. H. McLean.

District Manager: W. J. West, Virginia, Minn.

Yearly Shipments:

1914— 3,808 tons	1916—141,726 tons	1918—175,588 tons
1915— 49,212 tons	1917—195,552 tons	1919—154,491 tons

Total, tons 720,377

Analysis: See analyses of GROUPS 2, 3, 4, 7 and 9.

WARREN MINE

Location: St. Louis county, Minn., Sections 9 and 10, Township 57, Range 21.

Description: First opened up in 1917. The ore is a nonbessemer hematite. The mine is worked by the open-pit system. The ore is shipped via the Great Northern railway to Allouez, Wis., and thence by boat to lower lake ports.

Sales Agents: The Tod-Stambaugh Co., Cleveland, O.

Yearly Shipments:

1917— 94,030 tons	1918—195,008 tons	1919—159,150 tons

Total, tons 448,188

WEBB MINE

Location: St. Louis county, Minn., Section 6, Township 57, Range 20.

Description: First opened up in 1905. The ore is a soft, brown bessemer and nonbessemer hematite. The mine is worked by the underground and stripping system, the greatest vertical depth being 250 feet. The ore is shipped via the D., M. & N. railroad to the D., M. & N. docks at Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: The Shenango Furnace Co., Pittsburgh, Pa.

Manager: E. J. Maney.

Yearly Shipments:

1905— 71,235 tons	1910— 46,384 tons	1915—
1906—165,604 tons	1911— 20,237 tons	1916—140,279 tons
1907—113,334 tons	1912—166,636 tons	1917—210,593 tons
1908— 19,610 tons	1913—236,579 tons	1918—157,701 tons
1909—	1914— 151 tons	1919—176,402 tons

Total, tons 1,524,745

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Webb Bessemer:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.47	.040	6.93	.78	1.67	.14	...	....	6.35

Webb Nonbessemer:

57.11	.072	8.52	.58	.60	.20	.10	....	4.23

The ore in its natural state is as follows:

Webb Bessemer:

Moist.	Iron	Phos.	Silica
11.50	53.52	.035	6.13

Webb Nonbessemer:

6.75	50.79	.064	7.57

WEED MINE

Location: St. Louis county, Minn., Section 25, Township 59, Range 15.

Description: First opened up in 1914, but is now exhausted.

Yearly Shipments:

1914—	1916—113,447 tons	1918— 46,347 tons
1915— 73,670 tons	1917— 87,111 tons	1919—

Total, tons 320,575

WHITESIDE MINE

Location: St. Louis county, Minn., Section 15, Township 58, Range 19.

Description: First opened up in 1910. The ore is a soft, brown nonbessemer hematite. The mine is worked by the underground method, the greatest vertical depth being 250 feet. The ore is shipped via the D., M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: The Shenango Furnace Co., Pittsburgh, Pa.

Manager: E. J. Maney.

Yearly Shipments:

1911—130,198 tons	1914—242,996 tons	1917— 31,301 tons
1912—275,915 tons	1915— 31 tons	1918— 1,843 tons
1913— 76,897 tons	1916—	1919

Total, tons 759,181

WILLIAMS MINE

Location: St. Louis county, Minn., Section 2, Township 28, Range 16.

Description: First opened up in 1895, but is now abandoned.

WILLS MINE

Location: St. Louis county, Minn., Sections 17 and 18, Township 56, Range 16.

Description: First opened up in 1902, but is now idle.

Yearly Shipments:

1902— 12,158 tons	1906—	1910— 26,712 tons
1903—	1907—	1917—
1904—	1908—	1918— 17,662 tons
1905— 4,550 tons	1909— 3,440 tons	1919—

Total, tons 64,522

WINIFRED MINE

Location: St. Louis county, Minn., Section 31, Township 58, Range 20.

Description: First opened up in 1903, but is now inactive.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean.

District Manager: M. H. Godfrey, Hibbing, Minn.

Yearly Shipments:

1903— 39,179 tons	1909— 84,614 tons	1915— 41,489 tons
1904— 81,686 tons	1910— 67,686 tons	1916— 69,765 tons
1905—	1911— 52,385 tons	1917— 16,249 tons
1906— 3,415 tons	1912— 91,806 tons	1918—
1907— 94,867 tons	1913— 43,109 tons	1919—
1908— 61,341 tons	1914— 10,449 tons	

Total, tons 658,040

WISSTAR MINE

Location: St. Louis county, Minn., Section 17, Township 58 Range 16.

Description: First opened up in 1917. The ore is called the WISSTAR, and is a soft, brown, granular nonbessemer hematite. The mine is worked by underground caving and slicing, the greatest vertical depth being 175 feet. The ore is shipped by the D. & I. R. railroad to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Wisstar Mining Co.

Manager: Clement K. Quinn.

General Superintendent: Edward P. Scallon.

Sales Agents: Clement K. Quinn & Co.

Yearly Shipments:

1918— 20,609 tons 1919—

Analysis: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.75	.065	10.12	1.60	1.37	.11	.15	.021	5.62

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.40	51.16	.057	8.96

WOODBRIDGE MINE

Location: St. Louis county, Minn., Section 16, Township 58, Range 19.

Description: First opened up in 1912. The ore is a soft, light brown, granular nonbessemer hematite. The mine is worked by the slicing system, the greatest vertical depth being 255 feet. The ore is shipped via the D., M. & N. railroad to Duluth, Minn., and thence by boat to the lower lake ports.

Operating Company: The Fort Henry Mining Co., Wade Bldg., Cleveland, O.

Range Manager: E. W. Hopkins.

Superintendent: R. A. Angst.

Sales Agents: Oglebay, Norton & Co., Cleveland, O.

Yearly Shipments:

1912— 68,089 tons	1915—177,196 tons	1918—209,414 tons
1913—163,757 tons	1916—279,284 tons	1919—145,910 tons
1914— 71,440 tons	1917—236,442 tons	

Total, tons 1,351,532

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.50	.076	5.56	1.21	3.31	.41	.40	.014	6.32

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
14.44	49.20	.065	4.76

YORK MINE

Location: Itasca county, Minn., Section 31, Township 57, Range 22.

Description: First opened up in 1917. This mine ships two grades of ore: YORK (washed), a bessemer hematite, and RUGBY (washed), a nonbessemer hematite. The mine is worked by the open-pit system. Stripping operating has just started. The ore is shipped via the Great Northern railway to the G. N. docks at Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: York Iron Mining Co., Virginia, Minn.

Yearly Shipments:

1917— 55,131 tons	1918—122,834 tons	1919—146,977 tons

Total, tons 324,942

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

York:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.00	.044	11.40	.06	.68	.12	.06	.011	3.08

Rugby:

58.00	.056	11.57	.30	.96	.22	.11	.015	4.10

The ore in its natural state is as follows:

York:

Moist.	Iron	Phos.	Silica
6.75	55.02	.041	10.63

Rugby:

8.00	53.36	.052	10.64

YATES MINE

Location: St. Louis county, Minn., Section 11, Township 58, Range 19.

Description: First opened up in 1904, but is now idle.

Yearly Shipments:

1904— 53,179 tons	1906—265,289 tons	1908— 86,308 tons
1905— 58,174 tons	1907—210,289 tons	1909— 5,362 tons

Total, tons 679,038

YAWKEY MINE

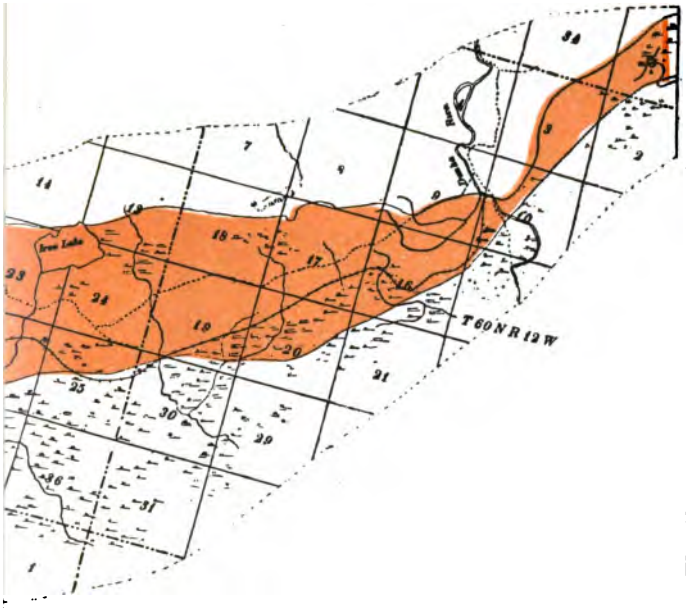
Location: St. Louis county, Minn., Section 9, Township 58, Range 17.

Description: First opened up in 1907, but is now idle.

Yearly Shipments:

1907— 15,453 tons	1910— 30,439 tons	1913— 40,878 tons
1908— 84,446 tons	1911—	
1909— 45,790 tons	1912—	

Total, tons 217,006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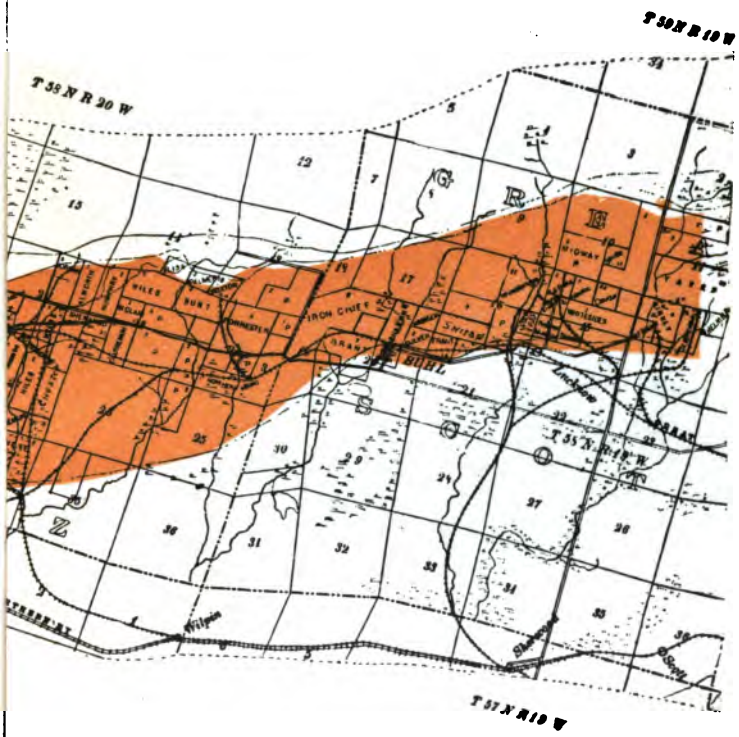
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IRON CREEK
HIGHWAY
Swamp
Landing
Wilgus
Shawnee
Gravel

[redacted]

CUYUNA RANGE

ADAMS MINE

Location: Crow Wing county, Minn., S. ½ of N. W. ¼ of Section 30, Township 46 N., Range 28 W.

Description: First opened up in 1913, but is now idle. The ore is a medium hard, red and brown, nonbessemer hematite. Six thousand tons were stockpiled. The mine will be worked by the slicing and caving systems, the greatest vertical depth being 207 feet. The ore will be shipped via the Northern Pacific railroad to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Biwanago Mining Co., Deerwood, Minn.

Manager: C. C. Adams.

Yearly Shipments:

1917—	1918— 5,535 tons	1919—

Total, tons 5,535

ALGOMA MINE (Formerly Hoch Mine)

Location: Crow Wing county, Minn., Section 33, Township 47, Range 29.

Description: First opened up in 1916. The ore is a hard and soft, purple and black manganiferous ore. The mine is worked by the top-slicing system, the greatest vertical depth being 160 feet. The ore is shipped via the Soo Line to the Soo docks at Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Onahman Iron Co., Omaha, Neb.

Manager: W. C. Fraser.

Superintendent: H. H. Hunner.

Sales Agents: W. H. Locker.

Yearly Shipments:

1915— 8,201 tons	1917— 22,097 tons	1919— 24,568 tons
1916— 24,035 tons	1918— 22,044 tons	

Total, tons 100,945

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
32.87	.082	19.40	17.15

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
7.27	30.48	.076	17.99

ARMOUR No. 1 MINE

Location: Crow Wing county, Ironton, Minn., S. E. ¼ of the N. E. ¼ of Section 10, Township 26 N., Range 29 W.

Description: First opened up in May, 1910. The ore is a medium hard, dark-red, nonbessemer hematite. Slicing and caving systems of mining are used, and part open-pit. The greatest

vertical depth is 300 feet. The ore is shipped via the Minneapolis, St. Paul & Sault Ste. Marie railroad to Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Inland Steel Co., Chicago, Ill.

Yearly Shipments:

1910—	1914	1918—101,747 tons
1911—	1915— 79,538 tons	1919—113,606 tons
1912— 49,539 tons	1916— 77,034 tons	
1913—105,087 tons	1917— 80,435 tons	

Total, tons 606,986

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
55.33	.207	8.32	.45

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.03	49.23	.184	7.40

ARMOUR No. 2 MINE

Location: Crow Wing county, Ironton, Minn., S. ½ of the N. W. of Section 11, Township 46 N., Range 29 W.

Description: First opened up in May, 1910. The ore is a medium hard, purplish-red nonbessemer hematite. Slicing and caving systems of mining are now used. The greatest vertical depth is 358 feet. The ore is shipped via the Minneapolis, St. Paul & Sault Ste. Marie railroad to Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Inland Steel Co., Chicago, Ill.

Yearly Shipments:

1910—	1914—283,565 tons	1918—246,362 tons
1911—	1915—303,280 tons	1919—227,600 tons
1912— 49,031 tons	1916—341,147 tons	
1913—175,665 tons	1917—273,812 tons	

Total, tons 1,900,462

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
55.45	.109	7.62	.23

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
12.25	48.66	.096	6.69

ARKO MINE

Location: Crow Wing county, Minn., Section 9, Township 46, Range 29.

Description: First opened up in 1918. The ore is a manganiferous ore. The mine is worked by the underground system, the greatest vertical depth being 108 feet. The ore is shipped via the Northern Pacific railway to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Arko Mining Co., 512 Andrus Bldg., Minneapolis, Minn.
Manager: Frank E. Oberg.
Superintendent: H. I. Pearl.
Yearly Shipments:

1918—	740 tons	1919—	284 tons
Total, tons			1,024

BARROWS MINE

Location: Crow Wing county, Minn., Section 10, Township 44, Range 31.
Description: First opened up in 1913, but is now idle.
Yearly Shipments:

1913—	9,089 tons	1914—	47,350 tons
Total, tons			56,439

CROFT MINE

Location: Crow Wing county, Minn., SE¼ of SW¼ and S½ of SW¼ of SW¼, Section 1, Township 46, Range 29.
Description: First opened up in 1914. The ore is a soft, purple or reddish-blue bessemer hematite. The mine is worked by the underground caving system, the greatest vertical depth being 333 feet. The ore is shipped via the Northern Pacific railroad to Allouez Bay, and then by boat to lower lake ports.
Operating Company: Merrimac Mining Co., Crosby, Minn.
Superintendent: Thomas Turnbull.
General Superintendent: John F. Murphy.
Sales Agents: John A. Savage & Co., Duluth, Minn.
Yearly Shipments:

1916—	68,867 tons	1918—	146,162 tons
1917—	149,899 tons	1919—	134,386 tons
Total, tons			499,314

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Croft Bessemer:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.42	.039	9.97	.06	1.92	.85	.37	.001	2.70

Croft Nonbessemer:

58.60	.060	10.47	.07	1.96	.40	.38	.001	2.79

The ore in its natural state is as follows:

Croft Bessemer:

Moist.	Iron	Phos.	Silica
10.86	53.86	.035	8.89

Croft Nonbessemer:

10.19	52.63	.054	9.40

FEIGH MINE

Location: Crow Wing county, Minn., S½-NW¼ and N½-SW¼ of Section 10, Township 46, Range 29.
Description: First opened up in 1917. The ore is a reddish-

brown, soft and granular nonbessemer hematite. The mine is worked by the underground, slice and cave systems, the greatest vertical depth being 145 feet. The ore is shipped via the Northern Pacific railroad to the N. P. docks at Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Northwestern Improvement Co., Ironton, Minn.

Manager: E. E. Hunner.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1917—	1918—	1919— 21,011 tons

Total, tons 21.011

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.10	.272	9.70	.22	2.79	.49	.13	.014	5.80

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
51.35	10.07	.247	7.82

FERRO MINE

Location: Crow Wing county, Minn., Section 32, Township 47, Range 29.

Description: First opened up in 1916. The ore is hard, very dark purple manganiferous. The underground system of mining is used, the greatest vertical depth being 150 feet. The ore is shipped via the Northern Pacific railroad to the N. P. docks, at Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Onahman Iron Co., Omaha, Nebraska.

Superintendent: H. H. Hunner.

Sales Agents: W. H. Locker.

Yearly Shipments:

1916— 14.501 tons	1918— 59,753 tons
1917— 62,674 tons	1919— 16,332 tons

Total, tons 153,264

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
29.85	.073	18.41	19.25

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
7.74	27.54	.067	16.98

GLORIA MINE (Formerly McKenzie)

Location: Crow Wing county, Minn., E. ½ S. E. ¼ Section 28, Township 47, Range 29.

Description: First opened up in 1916. The mine is in process of development. The mine is worked by underground methods, the greatest vertical depth being 110 feet. The ore

is manganiferous and will be shipped via the Soo Line to the Soo docks at Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Gloria Mining Co., 301 Alworth Bldg., Duluth, Minn.

Manager: E. J. W. Donahue.

Yearly Shipments:

1918—	5,000 tons	1919—	1,300 tons
Total, tons			6,300

Analysis: The expected analyses for 1920 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Loss
30.00	.170	15.00	16.00	3.50	.67	.26	9.32

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
8.00	27.60	.156	13.80

HILLCREST MINE

Location: Crow Wing County, Minn., Sections 9 and 10, Township 46, Range 29.

Description: First opened up in 1916. The ore is a soft, red nonbessemer hematite. The open-pit system of mining is used. The ore is shipped via the Northern Pacific railroad to Allouez, Wis., and thence by boat to lower lake ports.

Operating Company: Hillcrest Mining Co.

Manager: Wilbur VanEvera.

Superintendent: J. P. Anderson.

Yearly Shipments:

1916—	19,431 tons	1918—	118,812 tons
1917—	175,940 tons	1919—	141,245 tons
Total, tons			455,428

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Moist.
56.62	.198	7.21	.54	11.00

HUNTINGTON MINE

Location: Crow Wing county, Minn., Lots 4 and 5, NE¼ of SW¼, SW¼ of SW¼, Section 9, Township 46 N, Range 29 W.

Description: First opened up in 1918. The ore is a soft, red, nonbessemer hematite. The mine is worked by the underground slicing and caving system, the greatest vertical depth being 190 feet. The ore is shipped via the Soo line to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Whitmarsh Mining Co., Duluth, Minn.

Manager: G. H. Crosby.

Analysis: The expected analysis for 1920 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
54.50	.338	6.88	2.12

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.50	48.78	.0303	6.16

IRONTON MINE

Location: Crow Wing county, Minn., Section 11, Township 46, Range 29.

Description: First opened up in 1913. The ore is a hard non-bessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 300 feet. The ore is shipped via the Northern Pacific railroad to the N. P. docks at Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Cuyuna-Duluth Iron Co., 410 Lonsdale Bldg., Duluth, Minn.

Manager: W. H. Locker.

Superintendent: Paul P. Swanson.

Sales Agents: American Manganese Manufacturing Co., Philadelphia, Pa.

Yearly Shipments:

1913— 2,936 tons	1916— 51,769 tons	1919— 89,851 tons
1914— 40,425 tons	1917— 64,446 tons	
1915— 316 tons	1918— 39,968 tons	

Total, tons 289,711

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
58.91	.232	8.86	.96

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
15.12	50.01	.197	7.53

JOAN No. 1 MINE

Location: Crow Wing county, Minn., Section 3, Township 46, Range 29.

Description: First opened up in 1916. The ore is a manganiferous ore. The mine is worked by the underground system, the shaft having just been completed. The greatest vertical depth is 200 feet. The ore is shipped via the Soo Line to the Soo docks at Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Joan Mining Co., Duluth, Minn.

Manager: Marcus L. Fay.

Superintendent: George M. Fay.

Shipments:

1917— 3,490 tons	1918— 1,116 tons	1919— 732 tons

Total, tons 5,338

JOAN No. 2 MINE

Location: Crow Wing county, Minn., Section 3, Township 46, Range 29.

Description: First opened up in 1916. The ore is manganiferous. The mine is worked by the underground system. The greatest vertical depth is 200 feet. The ore is shipped via the Soo line to the Soo docks at Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Joan Mining Co., Duluth, Minn.

Manager: Marcus L. Fay.

Superintendent: George M. Fay.

KENNEDY MINE

Location: Crow Wing county, Minn., Sections 29 and 30, Township 47, Range 28.

Description: First opened up in 1907. The ore is a medium, brown, nonbessemer hematite. The mine is worked by the slicing and caving system, the greatest vertical depth being 362 feet. The ore is shipped via the Soo and N. P. railroads to the Soo docks and N. P. docks at Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Rogers, Brown Ore Co., 111 W. Washington St., Chicago.

Superintendent: G. A. Anderson.

Yearly Shipments:

1907—	1912—196,653 tons	1917—247,421 tons
1908—	1913—267,023 tons	1918—202,826 tons
1909—	1914—179,885 tons	1919—171,078 tons
1910—	1915—216,655 tons	
1911—147,431 tons	1916—166,915 tons	

Total, tons 1,795,887

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
54.85	.266	10.95	.258	2.42	.40	.39	.041	7.35

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.23	49.24	.233	10.19

MAHNOMEN MINE

Location: Crow Wing county, Minn., Sections 3 and 10, Township 46 N., Range 29 W.

Description: First opened up in 1915. This mine ships six grades of ore: MAHNOMEN, a fairly soft, coarse, red and brown nonbessemer hematite, MAHNOMEN SELECTED, lumpy, black manganese oxides with hematite, MAHNOMEN SPECIAL, lumpy, reddish to black manganese oxides with hematite, MAHNOMEN No. 1, a fairly soft, coarse, red and brown, high-manganese, nonbessemer hematite, MAHNOMEN No. 3 and MAHNOMEN No. 4, both fairly soft, coarse, red and brown, manganiferous nonbessemer hematites. The ores are of a structure similar to Old Range, less than 2 per cent through 100 mesh. The mine is worked

by the open-pit steam-shovel method, the greatest vertical depth being 250 feet. The ore is shipped via the Soo Line and Northern Pacific railroad to the Soo Line docks, Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Mahnomen Mining Co., Alworth Bldg., Duluth, Minn.

Manager: Clement K. Quinn.

General Superintendent: Edward P. Scallon.

Sales Agents: Clement K. Quinn & Co., Duluth, Minn., and Cleveland, O.

Yearly Shipments:

1916—146,602	tons	1918—321,114	tons
1917—285,027	tons	1919—146,239	tons

Total, tons 898,982

Analysis: Dried at 212 degrees Fahr.

Mahnomen:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.15	.191	6.14	1.05	3.67	.45	.33	.016	5.91

Mahnomen Selected:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
34.00	.310	3.90	22.60	3.20	.52	.37	.025	8.83

Mahnomen Special:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
36.17	.285	4.07	19.31	3.25	.53	.35	.027	8.85

Mahnomen No. 1:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
41.13	.297	5.10	13.56	3.25	.53	.35	.027	8.85

Mahnomen No. 3:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
47.60	.286	5.37	8.50	4.21	.62	.40	.021	9.60

Mahnomen No. 4:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
50.32	.274	6.95	5.10	3.25	.53	.35	.027	8.85

The ore in its natural state is as follows:

Mahnomen:

Moist.	Iron	Phos.	Silica
13.97	50.03	.164	5.28

Mahnomen Selected:

Moist.	Iron	Phos.	Silica
14.00	29.24	.266	3.35

Mahnomen Special:

Moist.	Iron	Phos.	Silica
14.55	30.91	.243	3.47

Mahnomen No. 1:

Moist.	Iron	Phos.	Silica
14.10	35.33	.255	4.38

Mahnomen No. 3:

Moist.	Iron	Phos.	Silica
14.15	40.86	.245	4.61

Mahnomen No. 4:

13.90	43.32	.235	5.98

MANGAN No. 1 MINE

Location: Crow Wing county, Minn., Section 3, Township 46, Range 29.

Description: First opened up in 1916. The ore, MANGAN No. 1, is a hard, dark-brown manganiferous ore. The mine is worked by the underground method, the greatest vertical depth being 160 feet. The ore is shipped via the Soo Line, to the Soo docks, at Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Mangan Iron & Steel Co.

Manager: W. G. Whitney.

Superintendent: W. G. Whitney.

Sales Agents: Mangan Iron & S[illegible] Co.

Yearly Shipments:

1916—	32,836 tons	1918—	43,007 tons
1917—	49,868 tons	1919—	93 tons

Total, tons 125,804

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Mang.	Silica
33.95	.191	17.76	17.80

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
7.62	31.36	.176	16.44

MANGAN No. 2 MINE

Location: Crow Wing county, Minn., N. E. ¼ of N. E. ¼ of Section 10, Township 46, Range 29.

Description: First opened up in June, 1916. The ore is mixed and graded with the several Mahnomen grades and shipped as such. The mine is worked by open-pit system, the greatest vertical depth being 250 feet. The ore is shipped via the Soo Line to the Soo docks, Superior Wis.

Operating Company: Mahnomen Mining Co., Alworth Bldg., Duluth, Minn.

Manager: Clement K. Quinn.

General Superintendent: Edward P. Scallon.

Sales Agents: Clement K. Quinn & Co., Duluth, Minn., and Cleveland, O.

Shipments: See Mahnomen mine.

Analysis: See Mahnomen grades.

MARTIN MINE

Location: Crow Wing county, Minn., Lot 2, Section 16, Township 46 N, Range 29 W.

Description: First opened up in 1917. The ore is a soft, red nonbessemer hematite. The mine is worked by the under-

ground slicing and caving system. The greatest vertical depth is 217 feet. The ore is shipped via the Soo line to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: Whitmarsh Mining Co., Duluth, Minn.

Manager: G. H. Crosby.

Yearly Shipments:

1918— 1,421 tons 1919—

Total, tons 1,421

Analysis: The expected analysis for 1920 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
56.00	.189	9.93	1.56

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
13.50	48.44	.163	8.59

MAROCO MINE

Location: Crow Wing county, Minn., Section 4, Township 46, Range 29.

Description: The mine is being stripped and will be worked by the open-pit system. Shipments will start during the fall of 1920. A washing plant is being installed. Two grades of ore will be shipped, MAROCO and MAROCO WASHED. The ore is a soft red, nonbessemer hematite. The ore is shipped via the Soo line and the Northern Pacific railroad to the Soo Line docks at Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Marquette Ore Co., Cleveland, O.

Manager: C. B. Dunster, Cleveland, O.

Superintendent: W. B. Pattison, Negaunee, Mich.

Sales Agents: E. N. Breitung & Co., Cleveland, O.

Analysis: The expected analyses for 1920 is as follows: Dried at 212 degrees Fahr.

Maroco:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.00	.100	9.00	1.00	.85	.50	.40	.008	6.00

Maroco Washed:

58.00	.100	7.00	1.00	.85	.50	.40	.008	6.00

The ore in its natural state is as follows:

Maroco:

Moist.	Iron	Phos.	Silica
9.00	50.96	.091	8.19

Maroco Washed:

9.00	52.78	.091	6.37

MEACHAM MINE

Location: Crow Wing county, Minn., Sections 11 and 12, Township 46, Range 29.

Description: First opened up in 1909. The ore is a soft and

hard, brown nonbessemer hematite. The mine is worked by the slicing and caving system, the greatest vertical depth being 354 feet. The ore is shipped via the Soo Line to the Soo docks at Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Rogers, Brown Ore Co., 111 W. Washington St., Chicago.

Superintendent: G. A. Anderson.

Yearly Shipments:

1916—	25,207 tons	1918—	160,598 tons
1917—	160,677 tons	1919—	150,975 tons

Total, tons 497,457

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.21	.221	8.65	.384	3.10	.443	.315	.037	6.33

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.14	50.51	.199	7.79

MILLE LACS MINE

Location: Crow Wing county, Minn., Section 3, Township 46, Range 29.

Description: First opened up in 1912. The ore, CROW WING, is a hard, manganiferous nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 205 feet. The ore is shipped via the Northern Pacific railroad to the N. P. docks at Superior, Wis, and thence by boat to the lower lake ports.

Operating Company: Cuyuna-Mille Lacs Iron Co., 410 Lonsdale Bldg., W. H. Locker.

Superintendent: Paul P. Swanson.

Sales Agents: American Manganese Mfg. Co., Philadelphia.

Yearly Shipments:

1912—		1915—	36,847 tons	1918—	158,075 tons
1913—	24,434 tons	1916—	90,564 tons	1919—	
1914—	51,292 tons	1917—	112,554 tons		

Total, tons 473,766

PENNINGTON MINE

Location: Crow Wing county, Minn., Section 10, Township 46, Range 29.

Description: First opened up in 1913. The ore is a soft, nonbessemer hematite. The mine is worked by the open-pit

system. The ore is shipped via the Soo line, to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: The Pennington Mining Co., Ironton, Minn.

Manager: J. S. Lutes.

Superintendent: F. P. Muloaney.

Sales Agents: Tod-Stambaugh Co., Cleveland, O.

Yearly Shipments:

1913—101,136 tons	1916—206,085 tons	1918—164,620 tons
1915—117,068 tons	1917—165,895 tons	1919—100,981 tons

Total, tons 855,785

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.00	.264	9.00	.37	2.75	.30	.23	.010	6.15

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.46	51.04	.236	8.06

ROWE MINE

Location: Crow Wing county, Minn., Sections 17 and 18, Township 46, Range 29.

Description: First opened up in 1913. The ore is a soft, red nonbessemer hematite. The mine is worked by milling system, the greatest vertical depth being 220 feet. The ore is shipped via the Soo Line to Soo docks, at Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: Pittsburgh Steel Ore Co., Riverton, Minn.

Manager: C. H. Munger.

Superintendent: W. P. Slaughter.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1913—	1916—180,239 tons	1919—126,344 tons
1914— 78,685 tons	1917—151,048 tons	
1915—137,598 tons	1918—109,435 tons	

Total, tons 783,349

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.10	.214	9.98	.26	2.93	.37	.33	.010	6.84

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.91	48.54	.189	8.79

ROWLEY MINE

Location: Crow Wing county, Minn., Section 16, Township 44, Range 31.

Description: First opened up in 1916, but not operating at present.

SAGAMORE MINE

Location: Crow Wing county, Minn., Section 19, Township 46, Range 29.

Description: First opened up in 1919. The ore is a soft, brown manganiferous hematite and is partly crushed. The mine is worked by the open-pit method. The ore is shipped via the Soo Line to Superior, Wis., and thence by boat to lower lake ports.

Operating Company: John A. Savage & Co., Crosby, Minn.

Superintendent: Clark Henry.

General Superintendent: John F. Murphy.

Sales Agents: John A. Savage & Co.

Yearly Shipments:

1919— 86,398 tons

Total, tons 86,398

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
43.97	.279	3.82	11.19	4.16	1.12	.51	.012	12.10

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.00	39.57	.251	3.44

SULTANA MINE

Location: Crow Wing county, Minn., Section 3, Township 46 N., Range 29 W.

Description: First opened up in 1915, but is now idle.

Yearly Shipments:

1916— 35,169 tons

Total, tons 35,169

THOMPSON MINE

Location: Crosby, Crow Wing county, Minn., Section 11, Township 46, Range 29.

Description: First opened up in 1911 but is now idle.

Operating Company: Maple Leaf Mining Co., Duluth, Minn.

Yearly Shipments:

1911—	1914—178,202 tons	1917—177,426 tons
1912— 9,888 tons	1915—202,227 tons	1918—112,227 tons
1913— 47,651 tons	1916—185,032 tons	1919—106,728 tons

Total, tons 1,019,381

WOODROW MINE (Formerly Omaha)

Location: Crow Wing county, Minn., Section 13, Township 45, Range 30

Description: First opened up in 1914. The ore is a soft, blue and reddish-brown nonbessemer hematite. The mine is worked by the slicing system; the greatest vertical depth be-

ing 235 feet. The ore is shipped via the N. P. railroad to the N. P. docks at Superior, Wis., and thence by boat to the lower lake ports.

Operating Company: The American Steel & Wire Corp., Cleveland, O.

Manager: S. F. Walsh.

Sales Agents: The Lake Superior Iron Ore Co., Cleveland, O.

Yearly Shipments:

1914—	1916— 50,454 tons	1918— 41,924 tons
1915— 34,383 tons	1917— 61,170 tons	1919— 91,372 tons

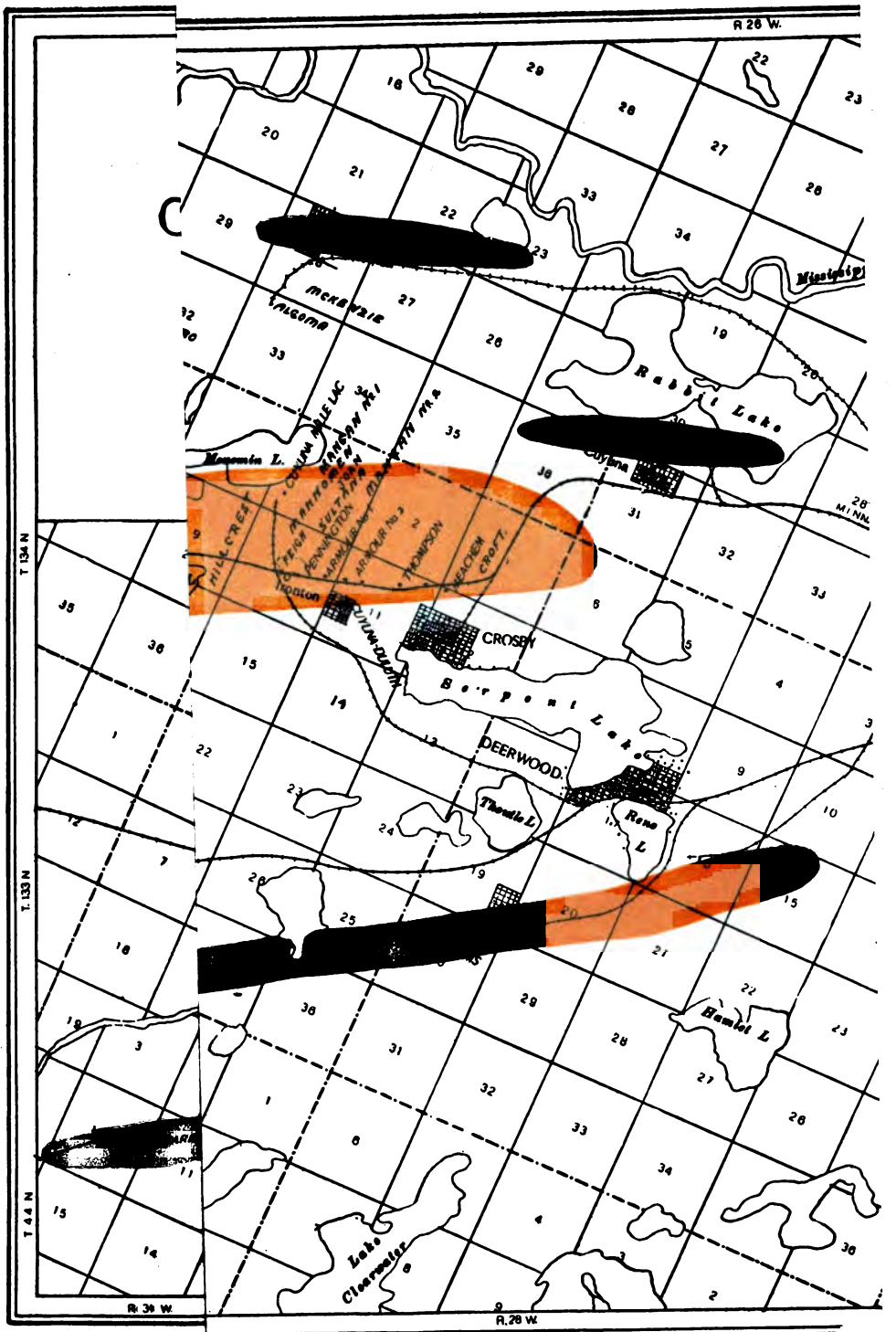
Total, tons 279,303

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
55.03	.252	8.79	.24

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
9.22	49.96	.229	7.98


R 26 W.
R 28 W.
R 30 W.
T 134 N
T. 133 N
T 44 N
McKenzie
Algoma
Rabbit Lake
Mississippi
Mazomin L.
Cyprus
MINN.
HICKCREST
COLUMBIA LAKE
MANGAN MI
MANITOBA
SULTANA
PENNINGTON
HARMONY
ARMOUR No 2
THOMPSON
BEACHEM
CROFT
Hopton
COLUMBIA
CROSBY
Serpent Lake
DEERWOOD
Thistle L
Rose L
Hamlet L
Lake Clearwater

GOGEBIC RANGE

ANVIL MINE

Location: Gogebic county, Mich., Section 14, Township 47, Range 46.

Description: First opened up in 1886. This mine ships two grades of ore: NORMAN and MONTROSE, hard, red non-bessemer hematite. The mine is worked by the sub-slicing system, the greatest vertical depth being 1600 feet. The ore is shipped via the C. & N. W. railroad to the C. & N. W. docks at Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: The Steel & Tube Co. of America, Milwaukee, Wis.

Manager: E. L. Cullen.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1887—	10,075	tons	1898—	5,037	tons	1909—	22,927	tons
1888—	24,676	tons	1899—			1910—	7,235	tons
1889—	47,000	tons	1900—			1911—	310	tons
1890—	45,690	tons	1901—	1,101	tons	1912—	56,845	tons
1891—	73	tons	1902—	135,502	tons	1913—		
1892—	42,090	tons	1903—	11,309	tons	1914—		
1893—			1904—	45,595	tons	1915—	2,804	tons
1894—	13,297	tons	1905—	82,118	tons	1916—		
1895—	68,064	tons	1906—	79,493	tons	1917—	54,407	tons
1896—	57,483	tons	1907—	39,495	tons	1918—	14,131	tons
1897—			1908—	35,937	tons	1919—	4,608	tons

Total, tons 907,311

Analysis: The average of all cargo analyses for 1919 is as follows:

Norman:

Iron	Phos.	Silica	Mang.
61.55	.060	7.02	.44

Montrose:

61.41	.057	7.59	.43

The ore in its natural state is as follows:

Norman:

Moist.	Iron	Phos.	Silica
10.86	54.87	.053	6.26

Montrose:

10.96	54.68	.053	6.76

ASHLAND MINE

Location: Gogebic county, Mich., Section 22, Township 47, Range 27.

Description: First opened up in 1884. This mine ships two

grades of ore: GLOBE, a hard and soft, red nonbessemer hematite, and ASHLAND, a soft, red bessemer hematite. The mine is worked by the caving and scramming systems, the greatest vertical depth being 1,324 feet. The ore is shipped via the C. & N. W. and the M., St. P. & S. Ste. M. railroads to Ashland, Wis., and thence by boat to lower lake ports.

Operating Company: Hayes Mining Co., Ironwood, Mich.

Manager: Robert King.

Superintendent: Robert King.

Sales Agents: L. R. Davidson & Co., White Bldg., Buffalo, N. Y.

Yearly Shipments:

1885— 6,741	tons	1897—111,625	tons	1909—259,612	tons
1886— 74,015	tons	1898—123,208	tons	1910—231,506	tons
1887—175,561	tons	1899—154,615	tons	1911—151,478	tons
1888—174,183	tons	1900—232,961	tons	1912—211,927	tons
1889—257,915	tons	1901—286,399	tons	1913— 2,635	tons
1890—435,949	tons	1902—301,824	tons	1914—133,250	tons
1891—267,439	tons	1903—274,138	tons	1915—112,932	tons
1892—231,896	tons	1904—344,102	tons	1916— 82,715	tons
1893— 66,067	tons	1905—409,131	tons	1917— 38,164	tons
1894— 83,020	tons	1906—341,841	tons	1918— 48,802	tons
1895—126,096	tons	1907—298,056	tons	1919— 36,359	tons
1896— 91,149	tons	1908—259,611	tons		

Total, tons 6,436,652

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Ashland:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
62.00	.035	8.00	.25	.82	.31	.13	.010	1.27

Globe:

57.25	.060	13.00	.28	1.10	.17	.15	.010	2.95

The ore in its natural state is as follows:

Ashland:

Moist.	Iron	Phos.	Silica
8.00	57.04	.032	7.36

Globe:

7.95	52.71	.055	11.97

ASTEROID MINE

Location: Gogebic county, Mich., Section 13, Township 47, Range 46.

Description: First opened up in 1906. This mine ships two grades of ore: ASTEROID, a soft, dark-red bessemer hematite, and RAMSAY, a soft, dark red nonbessemer hematite. The mine is worked by the slicing and caving system, the greatest vertical depth being 1226 feet. The ore is shipped

via the C. & N. W. railroad to Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: The Castile Mining Co., Wade Bldg., Cleveland, O.

Range Manager: E. W. Hopkins.

Superintendent: P. S. Williams.

Sales Agents: Oglebay, Norton & Co., Cleveland, O.

Yearly Shipments:

1911—	20,570	tons	1914—	135,119	tons	1917—	93,265 tons
1912—	70,240	tons	1915—	13,468	tons	1918—	121,152 tons
1913—	42,417	tons	1916—	89,876	tons	1919—	64,717 tons

Total, tons 650,824

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Asteroid:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
63.67	.048	5.93	.74	.87	.26	.16	.01	1.04

Ramsay:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
61.82	.138	7.65	.56	.103	.50	.16	.014	1.44

The ore in its natural state is as follows:

Asteroid:

Moist.	Iron	Phos.	Silica
11.00	56.66	.043	5.28

Ramsay:

Moist.	Iron	Phos.	Silica
11.10	54.96	.123	6.80

ATLANTIC MINE

Location: Iron county, Wis., Section 1 and 12, Township 45, Range 1.

Description: First opened up in 1887, but is now inactive.

Yearly Shipments:

1887—	1,369	tons	1896—	60,727	tons	1905—	208,039 tons
1888—			1897—	50,307	tons	1906—	97,689 tons
1889—			1898—	38,058	tons	1907—	91,759 tons
1890—			1899—	19,964	tons	1908—	41,465 tons
1891—			1900—	135,955	tons	1909—	124,845 tons
1892—			1901—	190,135	tons	1910—	79,847 tons
1893—			1902—	190,213	tons	1911—	
1894—			1903—	148,385	tons	1912—	142,080 tons
1895—	70,898	tons	1904—	77,424	tons	1913—	119,770 tons

Total, tons 1,888,820

BROTHERTON MINE

Location: Gogebic county, Mich., Section 9, Township 47, Range 45 W.

Description: First opened up in 1886. This mine ships three ores: BROTHERTON and CLARK, both hard, purple

bessemer hematites, and WALTON, a hard, purple nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 1342 feet. The ore is shipped via the C. & N. W. railroad to Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: Brotherton Iron Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. M. Hardenburgh.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1886— 8,880	tons	1898— 73,198	tons	1910—102,626	tons
1887— 21,721	tons	1899— 78,858	tons	1911— 65,015	tons
1888— 40,639	tons	1900— 89,804	tons	1912—148,930	tons
1889— 53,267	tons	1901—103,109	tons	1913— 70,138	tons
1890— 80,486	tons	1902— 53,255	tons	1914— 47,662	tons
1891— 46,574	tons	1903— 94,986	tons	1915—107,244	tons
1892—130,833	tons	1904— 84,870	tons	1916—107,813	tons
1893— 18,905	tons	1905—137,351	tons	1917— 84,524	tons
1894— 47,148	tons	1906—147,281	tons	1918— 6,905	tons
1895— 40,567	tons	1907—104,224	tons	1919— 5,002	tons
1896— 50,496	tons	1908— 96,776	tons		
1897— 46,186	tons	1909—103,090	tons		

Total, tons 2,498,357

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Clark:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
54.80	.029	19.20	.33	.66	.28	.17	.011	.37

The ore in its natural state is as follows:

Clark:

Moist.	Iron	Phos.	Silica
10.00	49.32	.026	17.28

CARY MINE

Location: Iron county, Mich., Sections 26 and 27, Township 46, Range 2 E.

Description: First opened up in 1886. This mine ships four grades of ore: CARY BESSEMER, a hard reddish-purple bessemer hematite; CARY EMPIRE, and NIMIKON, both hard, reddish-purple, nonbessemer hematites, and WINDSOR, a hard, purple bessemer hematite. The mine is worked by the underground sub-level stoping system, the greatest vertical depth being 1,322 feet. The ore is shipped via the C. & N. W. railroad to Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: Odanah Iron Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. M. Hardenburgh.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

Superior					
1886— 2,690 tons	1894— 16,559 tons	1913—217,349 tons			
1887— 27,763 tons	1895— 52,349 tons	1914— 68,464 tons			
1890— 36,675 tons	1896— 38,821 tons	1915—203,819 tons			
1891— 10,710 tons	1897— 37,308 tons	1916—308,834 tons			
1892— 13,192 tons	1898— 43,162 tons	**Windsor**			
1893—	1899— 62,524 tons	1889— 14,576 tons			
1894— 30,597 tons	1900—125,496 tons	1890— 37,210 tons			
Kakagon	1901—179,374 tons	1891— 97 tons			
1886— 18,497 tons	1902—136,895 tons	1892— 53,242 tons			
1887— 52,179 tons	1903— 89,221 tons	1893— 2,474 tons			
1888— 1,228 tons	1904— 61,860 tons	1894—			
Cary	1905—146,414 tons	1895— 11,438 tons			
1889— 56,542 tons	1906—216,992 tons	1896— 28,154 tons			
1890—116,203 tons	1907—209,407 tons	1897— 385 tons			
1891—123,193 tons	1908— 96,358 tons	1900— 488 tons			
1892—107,569 tons	1909—224,251 tons	1901— 841 tons			
1893— 28,598 tons	1910—205,674 tons	1917—253,260 tons			
	1911—120,017 tons	1918—231,523 tons			
	1912—308,292 tons	1919—197,180 tons			

Total, tons 4,283,488

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Cary Empire:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
54.50	.060	12.00	2.50	.87	.23	.17	.010	4.80

Nimikon:

57.95	.076	9.70	.41	1.50	.35	.36	.016	5.00

The ore in its natural state is as follows:

Cary Empire:

Moist.	Iron	Phos.	Silica
10.00	49.05	.054	10.80

Nimikon:

10.00	52.16	.068	8.73

CASTILE MINE

Location: Gogebic county, Mich., Section 10, Township 47, Range 45.

Description: First opened up in 1906. This mine ships two grades of ore: CASTILE, a soft, red bessemer hematite, and MEDINA, a soft, red nonbessemer hematite. The mine is worked by the slicing and caving system, the greatest vertical depth being 1,808 feet. The ore is shipped via the G. & N. W. railroad to Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: The Castile Mining Co., Wade Bldg., Cleveland, O.
Range Manager: E. W. Hopkins.
Superintendent: P. S. Williams.
Sales Agents: Oglebay, Norton & Co., Cleveland, O.
Yearly Shipments:

1906—	2,108 tons	1911—	23,598 tons	1916—	133,162 tons
1907—	6,157 tons	1912—	136,703 tons	1917—	82,248 tons
1908—		1913—	57,595 tons	1918—	73,063 tons
1909—	26,982 tons	1914—	36,569 tons	1919—	48,596 tons
1910—	20,197 tons	1915—	76,702 tons		

Total, tons 723,680

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Castile:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.58	.039	12.48	.58	.67	.27	.20	.012	.89

Medina:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.08	.095	15.60	1.57	.38	.40	.17	.012	1.24

The ore in its natural state is as follows:

Castile:

Moist.	Iron	Phos.	Silica
11.39	52.79	.035	11.06

Medina:

Moist.	Iron	Phos.	Silica
11.96	49.37	.085	13.73

COLBY MINE

Location: Gogebic county, Mich., Section 16, Township 47, Range 46.

Description: First opened up in 1884. This mine ships two ores: COLBY, soft, blue bessemer hematite, and COLBY No. 2, a soft, blue nonbessemer hematite. Underground system of mining is used. The ore is shipped via the Chicago & Northwestern railroad and the Soo Line to Ashland, Wis., and from there by boat to the lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.
Yearly Shipments:

1884—	1,022 tons	1896—	48,492 tons	1908—	58,305 tons
1885—	84,302 tons	1897—	22,921 tons	1909—	170,095 tons
1886—	257,432 tons	1898—	152,875 tons	1910—	194,754 tons
1887—	258,518 tons	1899—	103,239 tons	1911—	41,630 tons
1888—	285,880 tons	1900—	32,572 tons	1912—	245,195 tons
1889—	136,833 tons	1901—	23,475 tons	1913—	305,744 tons
1890—	193,038 tons	1902—	22,526 tons	1914—	291,947 tons
1891—	9,619 tons	1903—	54,915 tons	1915—	315,913 tons
1892—	69,968 tons	1904—	81,141 tons	1916—	423,553 tons
1893—	59,346 tons	1905—	83,736 tons	1917—	353,880 tons
1894—	32,616 tons	1906—	113,001 tons	1918—	324,731 tons
1895—		1907—	94,480 tons	1919—	268,129 tons

Total, tons 5,215,823

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Colby:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.29	.042	6.93	.51	1.82	.42	.42	.005	2.92

Colby No. 2:

60.02	.055	7.02	.44	1.63	.53	.57	.008	3.20

The ore in its natural state is as follows:

Colby:

Moist.	Iron	Phos.	Silica
10.90	53.72	.037	6.18

Colby No. 2:

Moist.	Iron	Phos.	Silica
10.91	53.47	.049	6.25

DAVIS MINE (Formerly Wisconsin)

Location: Gogebic county, Mich., Section 19, Township 47, Range 46.

Description: First opened up in 1890. The ore is a soft, brownish red nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 2,450 feet. The ore is shipped via the C. & N. W. railroad to Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Ironwood, Mich

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1890—	1,497	tons	1900—	3,569	tons	1910—		
1891—			1901—			1911—		
1892—	21,754	tons	1902—	31,530	tons	1912—		
1893—	15,210	tons	1903—	734	tons	1913—		
1894—			1904—	11,225	tons	1914—		
1895—	10,253	tons	1905—	3,160	tons	1915—	5,434	tons
1896—			1906—			1916—	4,997	tons
1897—			1907—			1917—	28,234	tons
1898—			1908—			1918—	2,820	tons
1899—	5,029	tons	1909—			1919—		

Total, tons 145,446

EUREKA MINE

Location: Gogebic county, Mich., Section 13, Township 47, Range 46.

Description: First opened up in 1890. This mine ships two grades of ore: BELMONT, a soft, red bessemer hematite, and EUREKA, a soft, red nonbessemer hematite. The mine

is worked by the slicing and caving system, the greatest vertical depth being 2000 feet. The ore is shipped via the C. & N. W. railroad to Ashland, Wis., and thence by boat to the lower lake ports:

Operating Company: The Castile Mining Co., Wade Bldg., Cleveland, O.

Range Manager: E. W. Hopkins.

Superintendent: P. S. Williams.

Sales Agents: Oglebay, Norton & Co., Cleveland, O.

Yearly Shipments:

1890—	23,794	tons	1900—			1910—	41,611	tons
1891—	13,907	tons	1901—			1911—	98,609	tons
1892—	10,655	tons	1902—			1912—	65,716	tons
1893—	31,385	tons	1903—			1913—	14,562	tons
1894—	18,329	tons	1904—			1914—	23,430	tons
1895—	26,105	tons	1905—			1915—	128,414	tons
1896—	4,544	tons	1906—	37,525	tons	1916—	207,959	tons
1897—			1907—	57,904	tons	1917—	191,630	tons
1898—			1908—	122,324	tons	1918—	189,696	tons
1899—			1909—	115,662	tons	1919—	146,307	tons

Total, tons 1,570,068

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Belmont:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
62.69	.046	6.90	.70	1.04	.29	.32	.012	1.09

Eureka:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.92	.092	8.53	.74	1.05	.53	.36	.009	1.21

The ore in its natural state is as follows:

Belmont:

Moist.	Iron	Phos.	Silica
11.25	55.64	.041	6.12

Eureka:

Moist.	Iron	Phos.	Silica
11.83	53.71	.81	7.52

GENEVA MINE

Location: Gogebic county, Mich., Section 18, Township 47 Range 46.

Description: First opened up in 1903. This mine ships two grades of ore: PURITAN, a soft, brownish-red bessemer hematite, and NORDEN, a soft, brownish-red nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 2,188 feet. The ore is shipped via the C. & N. W. railroad to Ashland, and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Ironwood, Mich.
General Manager: J. H. McLean.
General Superintendent: O. C. Davidson.
Yearly Shipments:

1903—	7,108	tons	1915—	34,416	tons	1918—	126,250	tons
1913—	31,303	tons	1916—	86,922	tons	1919—	27,667	tons
1914—			1917—	113,804	tons			

Total, tons 427,470

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Puritan:

Iron	Phos.	Silica	Mang.
61.88	.049	6.48	.778

Norden:

60.52	.084	7.61	.440

The ore in its natural state is as follows:

Puritan:

Moist.	Iron	Phos.	Silica
12.61	54.08	.043	5.66

Norden:

11.06	53.83	.075	6.77

GERMANIA MINE (HARMONY IRON CO.)

Location: Iron county, Wis., S. ½, S. W. ¼, Section 24 and undivided ¼ N. W. ¼, Section 25, Township 46, Range 2 East.

Description: First opened up in 1883, but is now idle.

Yearly Shipments:

1885—	5,468	tons	1894—			1904—	23,364	tons
1886—	19,734	tons	1895—			1905—	2,973	tons
1887—	61,714	tons	1896—			1906—	9,436	tons
1888—	53,918	tons	1897—	1,015	tons	1907—	19,319	tons
1889—	103,169	tons	1899—	1,255	tons	1909—	152	tons
1890—	52,000	tons	1900—	986	tons	1910—	20,080	tons
1891—	22,383	tons	1901—	10,358	tons	1912—	27,950	tons
1892—	4,283	tons	1902—	20,502	tons	1913—		
1893—	7,964	tons	1903—	2,246	tons			

Total, tons 470,269

IRONTON MINE

Location: Gogebic county, Mich., Section 17, Township 47, Range 46.

Description: First opened up in 1886. This mine ships two ores: IRONTON, a soft, red bessemer hematite, and IRONTON No. 2, a soft, red nonbessemer hematite. Underground system of mining is used. The ore is shipped via the C. &.

N. W. railroad and the Soo Line to Ashland, Wis., and thence by boat to lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1886—	18,242	tons	1898—			1910—	109,925	tons
1887—	24,762	tons	1899—	7,977	tons	1911—	63,359	tons
1888—			1900—	25,047	tons	1912—	173,135	tons
1889—	8,635	tons	1901—			1913—	166,123	tons
1890—	6,247	tons	1902—	8,555	tons	1914—	51,138	tons
1891—	300	tons	1903—	16,875	tons	1915—		
1892—			1904—	23,197	tons	1916—	148,191	tons
1893—			1905—	41,314	tons	1917—	244,517	tons
1894—			1906—	106,158	tons	1918—	184,627	tons
1895—			1907—	190,986	tons	1919—	212,207	tons
1896—			1908—	92,932	tons			
1897—			1909—	277,594	tons			

Total, tons 2,202,207

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Ironton:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.40	.043	6.65	.40	1.40	.65	.40	.007	3.70

Ironton No. 2:

60.90	.057	6.72	.45	1.71	.65	.58	.009	2.91

The ore in its natural state is as follows:

Ironton:

Moist.	Iron	Phos.	Silica
10.75	53.91	.038	5.94

Ironton No. 2:

10.90	54.26	.051	5.99

KEWEENAW MINE

Location: Gogebic county, Mich., Section 11, Township 47, Range 46.

Description: First opened up in 1913. This mine ships three ores: NORMAN, TOWER and MONTROSE, all hard, red nonbessemer hematites. The mine is worked by the subslicing system, the greatest vertical depth being 1600 feet. The ore is shipped via the C. & N. W. railroad to the C. & N. W. docks at Ashland, Wis., and thence by boat to lower lake ports.

Operating Company: The Steel & Tube Co. of America, Milwaukee, Wis.

Manager: E. L. Cullen.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1914—	5,771	tons	1916—	121,014	tons	1918—	142,037	tons
1915—	42,367	tons	1917—	130,374	tons	1919—	128,769	tons

Total, tons 570,332

Analysis: The average of all cargo analyses for 1919 is as follows:

Norman:

Iron	Phos.	Silica	Mang.
61.92	.061	6.51	.41

Montrose:

62.13	.059	6.38	.42

The ore in its natural state is as follows:

Norman:

Moist.	Iron	Phos.	Silica
10.84	55.21	.054	5.80

Montrose:

10.85	55.40	.053	5.69

MIKADO MINE

Location: Gogebic county, Mich., Section 18, Township 47, Range 45 W.

Description: First opened up in 1895 but is now idle.

Operating Company: Plymouth Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. M. Hardenburgh.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1895—	4,788	tons	1903—	108,709	tons	1911—	
1896—			1904—	25,611	tons	1912—	
1897—	11,397	tons	1905—	40,740	tons	1913—	33,111 tons
1898—			1906—	154,043	tons	1914—	2,094 tons
1899—	10,324	tons	1907—	163,891	tons	1915—	1,044 tons
1900—	1,090	tons	1908—	86,617	tons	1916—	23,741 tons
1901—	91,846	tons	1909—	99,195	tons	1917—	30,833 tons
1902—	98,834	tons	1910—	52,715	tons	1919—	995 tons

Total, tons 1,141,618

MONTREAL MINE

Location: Iron county, Wis., Section 33, Township 46, Range 2.

Description: First opened up in 1886. This mine ships three grades of ore: MONTREAL and LAWRENCE, soft, red, granular bessemer hematites, and HAMILTON, soft, red, granular nonbessemer hematite. The mine is worked by the slicing and caving systems, the greatest vertical depth being 2,300 feet. The ore is shipped via the M., St. P. & S. Ste. Marie railroad to Ashland, Wis., and thence by boat to lower lake ports.

Operating Company: The Montreal Mining Co., Wade Bldg., Cleveland, O.

Range Manager: E. W. Hopkins.

Superintendent: O. M. Schaus.

General Superintendent: F. B. Goodman.
Assistant Superintendent: J. M. Price.
Sales Agents: Oglebay, Norton & Co., Cleveland, O.
Yearly Shipments:

1886— 23,013	tons	1898—270,776	tons	1910—187,325	tons
1887— 43,989	tons	1899—153,307	tons	1911—153,122	tons
1888— 38,015	tons	1900—107,524	tons	1912—247,772	tons
1889— 42,724	tons	1901— 72,945	tons	1913—219,469	tons
1890— 16,828	tons	1902—136,354	tons	1914—229,559	tons
1891— 70,108	tons	1903—119,368	tons	1915—464,272	tons
1892— 58,728	tons	1904—164,153	tons	1916—530,813	tons
1893— 34,299	tons	1905—108,334	tons	1917—458,658	tons
1894— 46,037	tons	1906—137,849	tons	1918—298,896	tons
1895—138,882	tons	1907—156,119	tons	1919—319,604	tons
1896—131,531	tons	1908—177,006	tons		
1897—191,106	tons	1909—191,611	tons		

Total, tons 5,740,096

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Montreal:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
61.00	.033	8.43	.47	1.57	.24	.16	.009	1.95
Lawrence:								
60.55	.050	8.31	.39	1.42	.18	.14	.006	2.28
Hamilton:								
60.29	.058	8.11	.46	1.41	.29	.15	.009	3.52

The ore in its natural state is as follows:

Montreal:			
8.45	55.85	.030	7.72
Lawrence:			
9.10	55.04	.045	7.55
Hamilton:			
9.98	54.27	.052	7.30

MORGAN MINE

Location: Gogebic county, Mich., Section 11, Township 47 N, Range 45 W.

Description: This mine was first opened up in 1920. The ore, MORGAN, is a soft, red bessemer and nonbessemer hematite, and is crushed. Underground method is used, the greatest vertical depth being about 300 feet. This mine has no railroad connection as yet, but is ready to ship as soon as transportation facilities are furnished.

Operating Company: The Thomas Furnace Co., 740 Kinnickinnic Ave., Milwaukee, Wis.

Manager: G. A. Richards.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

NEWPORT MINE

Location: Gogebic county, Mich., Section 24, Township 47, Range 47.

Description: First opened up in 1886. This mine ships four ores: MELROSE and MELROSE SPECIAL, soft, red bessemer hematites, and MONTROSE and NORMAN soft, red nonbessemer hematites. The mine is worked by the sub-slicing system, the greatest vertical depth being 2300 feet. The ore is shipped via the C. & N. W. railroad to the C. & N. W. docks, at Ashland, Wis., and thence by boat to lower lake ports.

Operating Company: The Steel & Tube Co. of America, Milwaukee, Wis.

Manager: E. L. Cullen.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1886—	20,184	tons	1898—	196,953	tons	1910—	1,182,324	tons
1887—	75,660	tons	1899—	263,711	tons	1911—	560,760	tons
1888—	69,145	tons	1900—	217,201	tons	1912—	973,391	tons
1889—	36,987	tons	1901—	190,448	tons	1913—	1,146,730	tons
1890—	71,488	tons	1902—	141,571	tons	1914—	707,485	tons
1891—	105,606	tons	1903—	279,905	tons	1915—	838,875	tons
1892—	165,965	tons	1904—	171,931	tons	1916—	1,315,980	tons
1893—	109,718	tons	1905—	438,023	tons	1917—	1,003,229	tons
1894—	150,392	tons	1906—	549,745	tons	1918—	1,041,697	tons
1895—	157,821	tons	1907—	551,496	tons	1919—	907,291	tons
1896—	142,369	tons	1908—	579,390	tons			
1897—	150,979	tons	1909—	1,008,354	tons			

Total, tons 15,522,801

Analysis: The average of all cargo analyses for 1919 is as follows:

Melrose:

Iron	Phos.	Silica	Mang.
61.68	.041	6.43	.40

Montrose:

60.88	.062	6.61	.43

Norman:

60.32	.068	6.34	.44

The ore in its natural state is as follows:

Melrose:

Moist.	Iron	Phos.	Silica
11.79	54.41	.036	5.67

Montrose:

12.14	53.49	.054	5.81

Norman:

12.58	52.73	.059	5.54

NORRIE-AURORA MINE

Location: Gogebic county, Mich., Sections 22 and 23, Township 47, Range 47.

Description: First opened up in 1885. This mine ships three grades of ore: NORRIE and NORDALE, both soft, reddish-brown bessemer hematites, and NORDEN, a soft, reddish-brown nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 1,870 feet. The ore is shipped via the C. & N. W. and the Soo railroads to Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Ironwood, Mich

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

Pabst

1885—	1,103	tons
1886—	17,979	tons
1887—	19,906	tons
1888—	49,979	tons
1889—	96,376	tons
1890—	172,060	tons
1891—	130,226	tons
1892—	113,245	tons
1893—	104,510	tons
1894—	206,074	tons
1895—	219,960	tons
1896—	68,984	tons
1897—	220,496	tons
1898—	223,891	tons
1899—	263,869	tons
1900—	239,242	tons
1901—	198,686	tons

Norrie

1885—	15,419	tons
1886—	124,844	tons
1887—	237,254	tons
1888—	412,196	tons
1889—	674,394	tons
1890—	906,728	tons
1891—	758,572	tons
1892—	985,216	tons
1893—	472,062	tons
1894—	621,608	tons
1895—	738,480	tons
1896—	329,068	tons
1897—	604,281	tons
1898—	700,990	tons
1899—	714,669	tons
1900—	666,389	tons
1901—	660,965	tons
1902—	1,080,032	tons

Aurora

1884—	1,173	tons
1885—	4,249	tons
1886—	94,553	tons
1887—	159,252	tons
1888—	179,937	tons
1889—	199,865	tons
1890—	246,695	tons
1891—	83,554	tons
1892—	319,482	tons
1893—	179,028	tons
1984—	203,152	tons
1895—	245,883	tons
1896—	187,169	tons
1897—	166,122	tons
1898—	135,076	tons
1899—	170,369	tons
1900—	193,111	tons
1901—	223,747	tons
1902—	402,981	tons
1903—	355,365	tons
1904—	212,920	tons

Norrie Group

1905—	1,527,128	tons
1906—	1,245,097	tons
1907—	1,109,085	tons
1908—	773,243	tons
1909—	977,054	tons
1910—	1,333,006	tons
1911—	883,910	tons
1912—	1,500,732	tons
1913—	1,503,443	tons
1914—	984,242	tons
1915—	1,408,516	tons
1916—	1,855,863	tons
1917—	1,646,606	tons
1918—	1,550,802	tons
1919—	1,335,473	tons

Total, tons 38,055,517

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Norrie:

Iron	Phos.	Silica	Mang.
60.86	.043	6.97	.31

Nordale:

56.87	.044	12.30	.29

Norden:

60.53	.084	7.61	.44

The ore in its natural state is as follows:

Norrie:

Moist.	Iron	Phos.	Silica
11.08	54.12	.038	6.20

Nordale:

10.84	50.72	.039	10.96

Norden:

11.06	53.83	.075	6.77

NORTH MIKADO WORKINGS

Location: Gogebic county, Mich., N½ of N½ of NW¼ Section 18, Township 47, Range 45.

Description: First opened up in 1919. The ore, RAMSAY, is a soft dark-red nonbessemer hematite. The mine is worked by the slicing and caving method, the greatest vertical depth being 1200 feet. This mine is operated as a part of the Asteroid mine. The ore is shipped via the C. & N. W. railroad to Ashland, and thence by boat to lower lake ports.

Operating Company: The Castile Mining Co., Cleveland, O.

Manager: E. W. Hopkins.

Superintendent: P. S. Williams.

Sales Agents: Oglebay, Norton & Co., Cleveland, O.

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
61.82	.138	7.65	.56	1.03	.50	.16	.014	1.44

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.10	54.96	.123	6.80

NORTH NEWPORT MINE

Location: Gogebic county, Mich., Section 13, Township 47, Range 47.

Description: First opened up in 1915. The ore, DAVIS, is a soft, brownish-red nonbessemer hematite. The mine is worked by the underground system. The ore is shipped via the C. & N. W. railroad to Ashland, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ironwood, Mich

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1915—	32,356 tons	1917—	13,737 tons	1919—	
1916—	48,070 tons	1918—	728 tons		

Total, tons 94,891

OTTAWA MINE (Formerly Odanah Mine)

Location: Iron county, Wis., Section 27, Township 46, Range 2 E.

Description: First opened up in 1886. This mine ships two grades of ore: ONTARIO and QUEBEC, both soft, red, granular nonbessemer hematites. The mine is worked by the stoping system, the greatest vertical depth being 1,300 feet. The ore is shipped via the M., St. P. & S. Ste. Marie and the C. & N. W. railroads to Ashland, and thence by boat to lower lake ports.

Operating Company: The Montreal Mining Co., Wade Bldg., Cleveland, O.

Range Manager: E. W. Hopkins.

Superintendent: O. M. Schaus.

General Superintendent: F. B. Goodman.

Assistant Superintendent: J. M. Price.

Sales Agents: Oglebay, Norton & Co., Cleveland, O.

Yearly Shipments:

1886—	13,714	tons	1897—			1909—	100,223	tons
1887—	30,475	tons	1898—			1910—	83,389	tons
1888—	5,412	tons	1900—			1911—	44,643	tons
1889—	13,354	tons	1901—			1912—	111,396	tons
1890—	1,065	tons	1902—	26,141	tons	1913—	50,521	tons
1891—			1903—	87,929	tons	1914—	106,260	tons
1892—	6,711	tons	1904—	30,420	tons	1915—	196,486	tons
1893—	3,956	tons	1905—	21,986	tons	1916—	309,554	tons
1894—	2,437	tons	1906—	57,219	tons	1917—	215,401	tons
1895—			1907—	46,424	tons	1918—	225,783	tons
1896—			1908—	33,893	tons	1919—	140,305	tons

Total, tons 1,995,097

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Ontario:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
53.04	.063	8.57	5.41	1.27	.30	.45	.010	5.25

Quebec:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.90	.059	9.22	2.46	1.27	.47	.45	.014	4.06

The ore in its natural state is as follows:

Ontario:

Moist.	Iron	Phos.	Silica
10.77	47.33	.056	7.65

Quebec:

Moist.	Iron	Phos.	Silica
10.55	50.90	.053	7.25

PALMS MINE

Location: Gogebic county, Mich., Section 14, Township 47, Range 46.

Description: This mine ships three grades of ore: NORMAN, TOWER and MONTROSE, all hard, red nonbessemer hematites. The mine is worked by the sub-slicing system, the greatest vertical depth being 1,600 feet. The ore is shipped via the C. & N. W. railroad to the C. & N. W. docks, at Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: Dunn Iron Mining Co., Milwaukee, Wis.

Manager: E. L. Cullen.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

Prior to 1909—1,284,489 tons

1909—		1913—	88,682 tons	1917—	481,465 tons
1910—		1914—	174,177 tons	1918—	321,867 tons
1911—		1915—	442,422 tons	1919—	469,232 tons
1912—	39,552 tons	1916—	529,751 tons		

Total, tons 4,331,637

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Norman:

Iron	Phos.	Silica	Mang.
60.46	.125	7.84	.54

Montrose:

Iron	Phos.	Silica	Mang.
60.53	.120	7.77	.56

The ore in its natural state is as follows:

Norman:

Moist.	Iron	Phos.	Silica
9.84	54.51	.113	7.07

Montrose:

Moist.	Iron	Phos.	Silica
9.89	54.54	.108	7.00

PILGRIM MINE

Location: Gogebic county, Mich., Section 18, Township 47, Range 45.

Description: First opened up in 1919. The ore is a soft, nonbessemer hematite. The mine is worked by the open-pit system, the greatest vertical depth being 130 feet. The ore is shipped via the C. & N. W. railroad to Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: Plymouth Mining Co., Verona, Mich.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. M. Hardenburgh.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1919— 286 tons

Total, tons 286

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
62.30	.090	3.80	.47	1.63	.30	.31	.010	4.60

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
15.00	52.96	.077	3.23

PLUMER MINE

Location: Iron county, Mich., Section 6, Township 45, Range 2.

Description: First opened up in 1912, but is now idle. The greatest vertical depth is 1312 feet.

Yearly Shipments:

1912— 47,578 tons 1913— 51,053 tons

Total, tons 98,631

PLYMOUTH MINE

Location: Gogebic county, Mich., Section 18, Township 47, Range 45.

Description: First opened up in 1916. This mine ships two ores, PLYMOUTH and PLYMOUTH REX, soft, red nonbessemer hematites. The mine is worked by the open-pit system, the greatest vertical depth being 130 feet. The ore is shipped via the C. & N. W. railroad to the C. & N. W. docks, at Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: Plymouth Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. M. Hardenburgh.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1916—330,427 tons 1918—821,867 tons
1917—658,265 tons 1919—498,842 tons

Total, tons 2,309,401

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Plymouth:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
62.30	.090	3.80	.47	1.63	.30	.31	.010	4.60

Plymouth Rex:

58.00	.100	6.25	2.30	1.60	.11	.12	.014	5.00

The ore in its natural state is as follows:

Plymouth:

Moist.	Iron	Phos.	Silica
15.00	52.96	.077	3.23

Plymouth Rex:

16.00	48.72	.084	5.25

PURITAN MINE (Formerly Ruby Mine)

Location: Gogebic county, Mich., Section 17, Township 47, Range 46.

Description: First opened up in 1886. This mine ships two grades of ore: PURITAN, a soft, dark, reddish-brown bessemer hematite, and NORDEN, a soft, dark reddish-brown nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 1,867 feet. The ore is shipped via the C. & N. W. railroad to Ashland, Wis., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ironwood, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1886—	16,388	tons	1901—	21,788	tons	1914—	58.140	tons
1887—	45,000	tons	1904—	1,259	tons	1915—	80,367	tons
1888—	3,058	tons	1910—	50,019	tons	1916—	308,534	tons
1889—	9,472	tons	1911—			1917—	224,082	tons
1890—	11,694	tons	1912—	90,683	tons	1918—	218,243	tons
1891—	913	tons	1913—	64,463	tons	1919—	122,704	tons

Total, tons 1,327,077

Analysis: See analysis of PURITAN and NORDEN.

ROYAL MINE

Location: Gogebic county, Mich., Section 18, Township 47, Range 46.

Description: First opened up in 1913. This mine ships two grades of ore: NORRIE, a soft, dark reddish-brown bessemer hematite, and RAND, a soft, dark, reddish-brown nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 1876 feet. The ore is shipiped via the C. & N. W. railroad to Ashland, Wis., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ironwood, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1913—	10,659	tons	1916—	11,527	tons	1919—	48,885	tons
1914—	11,686	tons	1917—	30,302	tons			
1915—	8,004	tons	1918—	33,561	tons			

Total, tons 154,624

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Norrie:

Iron	Phos.	Silica	Mang.
60.86	.043	6.97	.31

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.08	54.12	.038	6.20

SUNDAY LAKE MINE

Location: Gogebic county, Mich., Section 10, Township 47, Range 45 W.

Description: First opened up in 1885. This mine ships two ores: SUNDAY LAKE, a hard, purple bessemer hematite, and EARL, a hard, purple nonbessemer hematite. The mine is worked by the underground and sub-level stoping systems, the greatest vertical depth being 1,494 feet. The ore is shipped via the C. & N. W. railroad to Ashland, Wis., and thence by boat to lower lake ports.

Operating Company: The Sunday Lake Iron Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: L. M. Hardenburgh.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1885—	1,405 tons	1897—	45,815 tons	1909—	93,712 tons
1886—	10,963 tons	1898—		1910—	115,486 tons
1887—	18,137 tons	1899—	12,526 tons	1911—	56,096 tons
1888—		1900—	74,097 tons	1912—	155,485 tons
1889—		1901—	89,997 tons	1913—	133,475 tons
1890—	6,010 tons	1902—	144,630 tons	1914—	54,327 tons
1891—	64,902 tons	1903—	91,383 tons	1915—	136,211 tons
1892—	56,046 tons	1904—	50,625 tons	1916—	188,771 tons
1893—	22,876 tons	1905—	79,209 tons	1917—	198,144 tons
1894—	34,323 tons	1906—	86,879 tons	1918—	131,425 tons
1895—	20,970 tons	1907—	101,899 tons	1919—	184,550 tons
1896—	89,441 tons	1908—	111,130 tons		

Total, tons 2,660,945

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Sunday Lake:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.85	.044	12.69	.23	1.66	.15	.08	.018	.80

Earl:

58.00	.100	13.00	.50	1.00	.50	.40	.015	1.06

The ore in its natural state is as follows:

Sunday Lake:

Moist.	Iron	Phos.	Silica
9.00	53.55	.040	11.55

Earl:

9.20	52.66	.091	11.80

TILDEN MINE

Location: Gogebic county, Mich., Section 15, Township 47, Range 46.

Description: First opened up in 1891. This mine ships two

grades of ore: TILDEN and TILDEN-NORDEN, both soft, dark reddish-brown nonbessemer hematites. The mine is worked by the underground system, the greatest vertical depth being 2,095 feet. The ore is shipped via the C. & N. W. railroad and the Soo Line to Ashland, Wis., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Bessemer, Mich

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1891— 28,415 tons	1901—446,670 tons	1911—138,387 tons
1892—233,356 tons	1902—468,672 tons	1912—158,151 tons
1893—135,118 tons	1903—211,534 tons	1913— 97,573 tons
1894—209,077 tons	1904—204,581 tons	1914—114,767 tons
1895—418,188 tons	1905—188,104 tons	1915— 99,516 tons
1896—250,205 tons	1906—169,697 tons	1916—110,733 tons
1897—276,890 tons	1907—312,496 tons	1917—108,641 tons
1898—287,203 tons	1908—111,184 tons	1918—126,149 tons
1899—500,830 tons	1909—154,506 tons	1919—128,618 tons
1900—481,909 tons	1910— 99,937 tons	

Total, tons 6,271,107

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Tilden:

Iron	Phos.	Silica	Mang.
60.49	.052	7.81	.68

Tilden-Norden:

60.50	.074	7.86	.074

The ore in its natural state is as follows:

Tilden:

Moist.	Iron	Phos.	Silica
10.97	53.86	.046	6.95

Tilden-Norden:

12.49	52.94	.065	6.88

TOWNSITE MINE

Location: Gogebic county, Mich., Section 22, Township 47, Range 47.

Description: First opened up in 1885 by the Oliver Iron Mining Co., but lease was taken over in 1916 by the Townsite Mining Co. The ore is a soft and hard reddish-brown bessemer hematite. The mine is worked by the slicing method, the greatest vertical depth being 300 feet. The ore is shipped via the C. & N. W. railroad to Ashland, Wis., and thence by boat to lower lake ports.

Operating Company: Townsite Mining Co., Youngstown, O.

Manager: F. J. Webb.

Superintendent: H. C. Jussen.

Yearly Shipments:

1917— 25,970 tons	1918— 83,428 tons	1919— 80,203 tons

Total, tons 189,601

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.53	.042	9.25	.21	2.44	.13	.11	.023	2.50

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.50	52.68	.037	8.19

WAKEFIELD MINE

Location: Gogebic county, Mich., Sections 16 and 17, Township 47, Range 45.

Description: First opened up in 1913. This mine ships two ores, ANDREWS, a soft, red nonbessemer hematite, and DUANE, a soft, dark-brown nonbessemer hematite. The mine is worked by the open-pit and underground system, the greatest vertical depth being 400 feet. The ore is shipped via the C. & N. W. railroad to Ashland, Wis., and thence by boat to lower lake ports.

Operating Company: The Wakefield Iron Co., Wakefield, Mich

Manager: Earl E. Hunner.

General Superintendent: W. C. Hart.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1913— 15,261 tons	1916—1,061,730 tons	1919— 603,966 tons
1914— 313,050 tons	1917—1,144,411 tons	
1915— 651,302 tons	1918—1,130,432 tons	

Total, tons 4,920,152

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Andrews:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
61.40	.089	4.74	.38	2.34	.37	.26	.009	4.03

Duane:

58.67	.084	4.56	2.35	2.15	.60	.59	.011	5.10

The ore in its natural state is as follows:

Andrews:

Moist.	Iron	Phos.	Silica
13.31	53.23	.077	4.11

Duane:

11.87	51.71	.074	4.02

YALE MINE

Location: Gogebic county, Mich., Section 16, Township 47, Range 46.

Description: First opened up in 1901. The mine ships three grades of ore: YALE, a soft, red bessemer hematite,

GLYUNA, a soft, red nonbessemer hematite, and SILICIOUS, a soft, red silicous hematite. The ore is not crushed. The mine is worked by the caving system, the greatest vertical depth being 1,780 feet. The ore is shipped via the C. & N. W. railroad and the Soo Line to Ashland, Wis., and thence by boat to the lower lake ports.

Operating Company: Charcoal Iron Co. of America, Detroit, Mich.

Manager: H. H. Bingham.

Superintendent: W. E. McRandle.

Sales Agents: Oglebay, Norton & Co., Cleveland, O.

Yearly Shipments:

1901— 12,836 tons	1908— 14,874 tons	1915— 42,632 tons
1902— 26,043 tons	1909— 71,458 tons	1916—149,155 tons
1903— 46,211 tons	1910—108,253 tons	1917— 73,633 tons
1904— 46,860 tons	1911—154,944 tons	1918—103,491 tons
1905— 60,224 tons	1912— 76,772 tons	1919—270,006 tons
1906— 56,657 tons	1913— 89,482 tons	
1907— 38,010 tons	1914— 19,075 tons	

Total, tons 1,460,616

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Yale:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
65.33	.023	3.80	.21	1.66	.41	.30	.006	.60

Giyuna:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.23	.062	6.07	.48	2.45	.44	.52	.013	3.68

The ore in its natural state is as follows:

Yale:

Moist.	Iron	Phos.	Silica
12.00	57.49	.020	3.24

Glyuna:

Moist.	Iron	Phos.	Silica
14.17	51.70	0.53	5.21

MENOMINEE RANGE

ARAGON MINE

Location: Dickinson county, Mich., Sections 8 and 9, Township 39, Range 29.

Description: First opened up in 1889. This mine ships four grades of ore: GRANADA, a soft, blue nonbessemer hematite, CADIZ, a hard, blue silicious hematite, PENOID and PENOID-CADIZ, a hard, blue nonbessemer, silicious hematite. All ores are crushed. The mine is worked by the underground system, the greatest vertical depth being 1632 feet. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company:. Oliver Iron Mining Co., Norway, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1889— 1,745 tons	1900—404,645 tons	1911—201,187 tons
1890— 46,609 tons	1901—477,212 tons	1912—244,894 tons
1891— 96,829 tons	1902—646,203 tons	1913—230,958 tons
1892—167,948 tons	1903—522,035 tons	1914—188,765 tons
1893—127,901 tons	1904—374,944 tons	1915—302,275 tons
1894—138,209 tons	1905—423,698 tons	1916—244,478 tons
1895—183,296 tons	1906—431,000 tons	1917—276,434 tons
1896— 95,809 tons	1907—441,636 tons	1918—305,726 tons
1897—149,594 tons	1908—226,354 tons	1919—188,098 tons
1898—295,821 tons	1909—246,984 tons	
1899—337,807 tons	1910—241,046 tons	

Total, tons 8,260,140

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Granada (Brier Hill):

Iron	Phos.	Silica	Mang.
59.06	.048	6.58	.152

Granada (Townsite)

58.74	.058	7.36	.189

Cadiz (Townsite):

53.81	.057	11.79	.186

Penoid:

60.18	.065	9.12	.169

Penoid Cadiz:

53.82	.057	17.59	.182

The ore in its natural state is as follows:

Granada (Brier Hill):

Moist.	Iron	Phos.	Silica
7.74	54.49	.045	6.07

Granada (Townsite)

7.53	54.32	.054	6.81

Cadiz (Townsite):

7.70	49.67	.052	10.88

Penoid:

7.60	55.60	.060	8.43

Penoid Cadiz:

7.19	49.95	.053	16.33

ARMENIA MINE

Location: Iron county, Mich., Section 23, Township 43, Range 32.

Description: First opened up in 1889, but is now idle.

Yearly Shipments:

1889—	50,275	tons	1899—			1909—	
1890—	26,649	tons	1900—			1910—	65,473 tons
1891—			1901—	18,750	tons	1911—	51,863 tons
1892—			1902—	100,864	tons	1912—	150,808 tons
1893—			1903—	31,901	tons	1913—	83,142 tons
1894—			1904—	16,577	tons	1914—	50,501 tons
1895—	2,045	tons	1905—			1915—	
1896—			1906—	27,882	tons	1916—	
1897—			1907—	36,665	tons		
1898—			1908—				

Total, tons 713,395

BAKER MINE

Location: Iron county, Mich., Section 31, Township 43, Range 34.

Description: First opened up in 1909, but is now idle.

Yearly Shipments:

1909—	45,003	tons	1912—			1915—	41,378 tons
1910—	39,417	tons	1913—	24,286	tons	1916—	
1911—	3,290	tons	1914—	113,733	tons		

Total, tons 267,107

BALKAN MINE

Location: Iron county, Mich., Section 13, Township 42, Range 33.

Description: First opened up in 1915. The ore is a red, hard nonbessemer hematite, and is partially crushed. The mine is worked by the milling and underground system, the greatest vertical depth being 336 feet. The ore is shipped via the C. & N. W. and C., M. & St. P. railways to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Balkan Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1915—	144,284	tons	1917—	261,014	tons	1919—	159,921 tons
1916—	229,195	tons	1918—	262,293	tons		

Total, tons 1,056,707

Analysis: See analysis of OSANA.

BALTIC MINE

Location: Iron county, Mich., Section 7, Township 42, Range 34.

Description: First opened up in 1901. The ore is a hard, red, nonbessemer hematite, and is partially crushed. The mine is worked by the underground stoping system, the greatest vertical depth being 653 feet. The ore is shipped via the C. & N. W. railway to the C. & N. W. docks, at Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Verona Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1901— 17,326 tons	1908—129,037 tons	1915— 10,078 tons
1902— 64,664 tons	1909—174,426 tons	1916—110,965 tons
1903—123,236 tons	1910—171,930 tons	1917— 89,307 tons
1904—151,114 tons	1911— 66,502 tons	1918—141,903 tons
1905—133,246 tons	1912—100,736 tons	1919—
1906—186,495 tons	1913—130,631 tons	
1907—189,119 tons	1914— 29,206 tons	

Total, tons 2.019,921

Analysis: See analysis of OSANA.

BATES MINE

Location: Iron county, Mich., Section 19, Township 43, Range 34.

Description: First opened up in 1910. This mine produces two ores: BATES SCREENED, a soft, yellow nonbessemer hematite, and BATES LUMP, a hard, blue bessemer hematite. The ore is crushed. The mine is worked by the underground stoping system, the greatest vertical depth being 1,050 feet. The ore is shipped via the C. & N. W. and the C. M. & St. P. railroads to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: Bates Iron Co., Iron River, Mich.

General Manager: Felix A. Vogel.

Superintendent:. Andre Formis.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1915— 45,171 tons	1917—141,890 tons	1919— 91,049 tons
1916— 73,188 tons	1918— 98,194 tons	

Total, tons 449,492

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Bates Screened:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.22	.374	4.61	.15	1.55	.12	.25	.054	....

Bates Lump:

60.80	352	1.95	.19	.86	.30	.15	.035	....

The ore in its natural state is as follows:

Bates Screened:

Moist.	Iron	Phos.	Silica
6.91	54.20	.348	4.29

Bates Lump:

2.76	59.12	.342	1.90

BENGAL MINE

Location: Iron county, Mich., Section 36, Township 43, Range 35.

Description: First opened up in 1913. Two grades of ore are shipped: BALTIC, a hard, red nonbessemer hematite, and BENGAL MANGANESE, a nonbessemer manganiferous hematite. Both ores are partially crushed. The mine is worked by the underground slicing system, the greatest vertical depth being 376 feet. The ore is shipped via the C. & N. W. and the C. M. & St. P. railroads to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Verona Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1913— 23,259 tons	1916—140,961 tons	1919—229,501 tons
1914— 5,539 tons	1917—260,377 tons	
1915— 39,615 tons	1918—303,788 tons	

Total, tons 1,003,040

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Bengal Manganese:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
38.00	.347	4.86	17.96	2.94	1.97	3.56	.020	6.63

The ore in its natural state is as follows:

Bengal Manganese:

Moist.	Iron	Phos.	Silica
6.60	35.49	.324	4.54

BERKSHIRE MINE

Location: Iron county, Mich., Section 6, Township 42, Range 34.

Description: First opened up in 1908. The ore is a soft, red nonbessemer hematite, and is crushed to 3-inch size. The mine is worked by the caving system, the greatest vertical depth being 492 feet. The ore is shipped via the C. & N. W. railroad to the C. & N. W. docks at Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Brule Mining Co., Wade Bldg., Cleveland, O.

Range Manager: E. W. Hopkins.

Superintendent: F. J. Smith.

Sales Agents: Oglebay, Norton & Co., Cleveland, O.

Yearly Shipments:

1908—	3,440	tons	1912—	33,419	tons	1916—	38,467	tons
1909—	34,295	tons	1913—			1917—	57,791	tons
1910—	97,999	tons	1914—	23,824	tons	1918—	38,439	tons
1911—	22,273	tons	1915—	15,413	tons	1919—	49,073	tons

Total, tons 414,433

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.81	.68	6.52	.25	3.44	3.30	2.40	.041	2.85

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.17	50.13	.61	5.86

BREEN MINE

Location: Dickinson county, Mich., Section 22, Township 39, Range 28.

Description: The mine was opened prior to 1887 and is the oldest mine on the Menominee range. The present workings were opened up in 1904. The mine is now idle.

Yearly Shipments:

			Prior to 1887—	17,430	tons			
1905—	16,625	tons	1906—	21,004	tons	1907—	20,366	tons

Total, tons 74,425

BRISTOL MINE (Formerly Claire Mine)

Location: Iron county, Mich., Section 19, Township 43, Range 32.

Description: First opened up in 1892. The ore, MANGANATE, is a hard, brown nonbessemer hematite. It is crushed to 3-inch size. The mine is worked by the stoping system, the greatest vertical depth being 1,274 feet. The ore is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: The Bristol Mining Co., Wade Bldg., Cleveland, O.

Range Manager: E. W. Hopkins.

Superintendent: Arvid Bjork.

Sales Agents: Oglebay, Norton & Co., Cleveland, O.

Yearly Shipments:

1892—	57,352	tons	1902—	129,035	tons	1912—	435,619	tons
1893—	9,612	tons	1903—	246,581	tons	1913—	379,168	tons
1894—			1904—	132,420	tons	1914—	172,034	tons
1895—			1905—	210,388	tons	1915—	378,786	tons
1896—			1906—	298,031	tons	1916—	462,559	tons
1897—			1907—	345,676	tons	1917—	188,907	tons
1898—			1908—	190,300	tons	1918—	245,151	tons
1899—	80,915	tons	1909—	396,825	tons	1919—	58,184	tons
1900—	51,639	tons	1910—	270,742	tons			
1901—	36,593	tons	1911—	322,647	tons			

Total, tons 5,099,164

Analysis: The average of all cargo analyses for 1919 is as follows:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
48.92	.612	7.60	4.04	3.25	3.36	2.32	.155	6.63

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
7.13	45.43	.568	7.06

BUCKEYE MINE

Location: Florence county, Wis., Section 33, Township 40, Range 18.

Description: First opened up in 1909, but is now idle.

1910— 89,116 tons

Total, tons 89,116

CALUMET MINE

Location: Dickinson county, Mich., Section 8, Township 41, Range 23.

Description: First opened up in 1906. The ore is a hard, red nonbessemer, siliceous hematite, and is crushed. The mine is worked by the underground system, the greatest vertical depth being 215 feet. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: Calumet Ore Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

	Prior to 1894— 38,713 tons	
1906— 15,773 tons	1909—	1912— 35,587 tons
1907— 51,646 tons	1910—	1913— 18,976 tons
1908— 15,222 tons	1911—	

Total, tons 175,917

CARDIFF MINE

Location: Iron county, Mich., Section 22, Township 43, Range 35.

Description: First opened up in 1919. A shaft is being sunk in readiness to develop the property.

Operating Company: Wickwire Mining Co., Iron River, Mich.

Manager: E. C. Bowers.

Superintendent: H. E. Duff.

CARPENTER MINE

Location: Iron county, Mich., Section 31, Township 43, Range 32.

Description: First opened up in 1913. The ore is a hard and soft, red, high-phosphorus nonbessemer hematite. The mine is worked by the slicing and stoping systems, the greatest

vertical depth being 500 feet. The ore is shipped via the C., M. & St. P. and the C. & N. W. railroads to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: The Hollister Mining Co., Crystal Falls, Mich.

Manager: Earl E. Hunner.

General Superintendent: Alfred Martin.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1913—	1916—240,114 tons	1919—396,224 tons
1914— 51,146 tons	1917—269,387 tons	
1915—284,088 tons	1918—384,148 tons	

Total, tons 1,625,107

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.30	.571	8.11	.47	2.87	1.84	2.12	.096	4.20

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
9.57	50.01	.516	7.33

CASPIAN MINE

Location: Iron county, Mich., Section 1, Township 42, Range 35.

Description: First opened up in 1903. The ore, BALTIC, is a hard, red, nonbessemer hematite. The mine is worked by the underground slicing system, the greatest vertical depth being 389 feet. The ore is shipped via the C. & N. W. railway to the C. & N. W. docks at Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: The Verona Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1903— 2,088 tons	1909—189,023 tons	1915—479,084 tons
1904— 4,242 tons	1910—171,334 tons	1916—448,631 tons
1905— 10,248 tons	1911—165,660 tons	1917—411,705 tons
1906— 80,875 tons	1912—306,913 tons	1918—346,028 tons
1907—138,867 tons	1913—295,841 tons	1919—315,328 tons
1908—102,628 tons	1914—279,379 tons	

Total, tons 3,747,875

Analysis: See analysis of OSANA.

CHAPIN MINE

Location: Dickinson county, Mich., Sections 25 and 30, Township 40, Ranges 30 and 31.

Description: First opened up in 1880. This mine ships three grades of ore: CHAPIN, a soft, dark, bluish-gray non-

bessemer hematite, AJAX, a hard, reddish-brown nonbessemer hematite, and JUNO, a soft, bluish-gray nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 1522 feet. The ore is shipped via the C., M. & St. P. and the C. & N. W. railroads to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Iron Mountain, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

Prior to 1909—15,594,769 tons

1909— 587,647 tons	1913— 370,211 tons	1917— 682,349 tons
1910— 465,543 tons	1914— 340,722 tons	1918— 705,803 tons
1911— 357,598 tons	1915— 384,654 tons	1919— 545,050 tons
1912— 327,571 tons	1916— 557,485 tons	

Total, tons 20,919,402

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Chapin:

Iron	Phos.	Silica	Mang.
58.13	.058	5.46	.228

Ajax:

51.59	.062	16.26	.200

Juno:

53.20	.041	7.93	.247

The ore in its natural state is as follows:

Chapin:

Moist.	Iron	Phos.	Silica
6.49	54.36	.055	5.10

Ajax:

5.97	48.51	.058	15.29

Juno:

7.08	49.44	.038	7.37

CHATHAM MINE

Location: Iron county, Mich., Section 35, Township 43, Range 35.

Description: First opened up in 1907, but was abandoned in 1919.

Yearly Shipments:

1907— 14,833 tons	1912—134,079 tons	1917—244,934 tons
1908— 45,826 tons	1913—107,608 tons	1918—246,648 tons
1909— 68,730 tons	1914— 19,454 tons	1919— 51,761 tons
1910— 51,988 tons	1915—132,779 tons	
1911— 58,056 tons	1916—188,808 tons	

Total, tons 1,365,554

CHICAGON MINE

Location: Iron county, Mich., Section 26, Township 43 N, Range 34 W.

Description: First opened up in 1909. This mine ships three grades of ore: CHICAGON, MANGROVE and HAROLD, all hard, red nonbessemer hematites. The mine is worked by the underground stoping method, the greatest vertical depth being 1060 feet. The ore is shipped via the C. & N. W. and the C. M. & St. P. railroads to the C. & N. W. and the C., M. & St. P. docks at Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Munro Iron Mining Co., Iron River, Mich.

Manager: G. L. Woodworth.

Yearly Shipments:

1909—	1913—137,002 tons	1917— 90,786 tons
1910—	1914—114,848 tons	1918—109,574 tons
1911—108,947 tons	1915—155,711 tons	1919— 82,655 tons
1912—149,619 tons	1916—100,640 tons	

Total, tons 1,049,782

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Chicagon:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.17	.488	8.63	.72	2.59	1.63	2.31	.05	6.58

Mangrove:

48.42	.534	7.54	5.64	2.50	1.50	2.13	.04	6.52

The ore in its natural state is as follows:

Chicagon:

Moist.	Iron	Phos.	Silica
8.59	50.43	.410	7.89

Mangrove:

5.98	45.52	.502	7.09

CLIFFORD MINE (Formerly Traders)

Location: Dickinson county, Mich., Section 20, Township 40, range 30.

Description: First opened up in 1895. This mine ships two grades of ore: CLIFFORD, a hard, grayish-blue, siliceous bessemer, semispecular hematite, and ANTOINE, a grayish-blue, siliceous nonbessemer, semispecular hematite. Beginning in 1920, shipments of Clifford low-phosphorus will be made. The phosphorus is guaranteed .014 (dry).

Operating Company: Antoine Ore Co., Youngstown, O.

Manager: F. J. Webb.

Superintendent: Frank Carbis.

Yearly Shipments:

1895— 27,931 tons	1904— 81,164 tons	1913— 95,310 tons
1896—110,821 tons	1905—138,395 tons	1914— 66,329 tons
1897— 98,847 tons	1906—195,855 tons	1915—
1898—104,510 tons	1907—100,996 tons	1916—113,361 tons
1899— 93,025 tons	1908—	1917—115,823 tons
1900—119,940 tons	1909—103,626 tons	1918—118,494 tons
1901— 63,429 tons	1910— 91,081 tons	1919—
1902—110,993 tons	1911— 74,138 tons	
1903—107,886 tons	1912—	

Total, tons 2,131,694

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Antoine:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
38.62	.030	42.13	.15	.95	.59	.75	.017	1.05

Clifford:

40.10	.019	38.54	.10	.99	.90	.73	.011	1.12

The ore in its natural state is as follows:

Antoine:

Moist.	Iron	Phos.	Silica
1.95	37.87	.029	41.31

Clifford:

2.90	38.94	.018	37.42

COTTRELL MINE

Location: Iron county, Mich., Section 1, Township 42, Range 35.

Description: First opened up in 1915, but is now idle.

Yearly Shipments:

1915— 45 tons 1916— 75,089 tons

Total, tons 75,134

CRYSTAL FALLS MINE

Location: Iron county, Mich., Section 21, Township 43, Range 32.

Description: First opened up in 1882, but is now idle.

Yearly Shipments:

Prior to 1909—1,735,251 tons

1910—		1913— 7,389 tons	1916—
1911—	710 tons	1914—	
1912—	665 tons	1915—	

Total, tons 1,744,015

CUNDY MINE

Location: Dickinson county, Mich., Section 3, Township 39, Range 30.

Description: First opened up in 1896 but is now inactive.

Yearly Shipments:

1896— 3,395 tons	1900—141,148 tons	1909— 5,512 tons
1897— 41,942 tons	1901—178,800 tons	1913— 2,543 tons
1898— 76,877 tons	1902—183,052 tons	
1899—100,903 tons	1903—111,851 tons	

Total, tons 846,023

DAVIDSON No. 1 MINE

Location: Iron county, Mich., Section 23, Township 43, Range 35.

Description: First opened up in 1911. This mine ships two grades of ore: DAVIDSON and STERLING, both soft, yellow high-grade nonbessemer limonites. The mine is worked by the stoping systems, the greatest vertical depth being 550 feet. The ore is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Davidson Ore Mining Co., Buffalo, N. Y.

Manager: T. F. Hildreth.

Superintendent: Rudolph Ericson.

Sales Agents: Davidson Ore Mining Co., Buffalo, N. Y.

Yearly Shipments:

1911— 45,434 tons	1914—122,567 tons	1917—223,990 tons
1912—126,207 tons	1915—152,430 tons	1918—113,779 tons
1913—195,448 tons	1916—164,248 tons	1919—262,048 tons

Total, tons 1,406,151

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Davidson:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.87	.447	6.53	.25	2.31	.63	.47	.062	8.80

Sterling:

55.94	.442	6.33	.20	2.45	.54	.56	.055	8.42

Clifton:

55.24	.429	6.05	.25	3.55	.50	.54	.059	9.00

The ore in its natural state is as follows:

Davidson:

Moist.	Iron	Phos.	Silica
7.31	51.79	.414	6.05

Sterling:

7.35	51.83	.410	5.87

Clifton:

7.95	50.85	.395	5.57

DAVIDSON No. 2 MINE

Location: Iron county, Mich., Section 14, Township 43, Range 35.

Description: First opened up in 1911. This mine ships three grades of ore: DAVIDSON, STERLING and CLIFTON, all of which are soft, yellow, high-grade nonbessemer limonites. The sub-level caving and shrinkage stope methods of

mining are used. The greatest vertical depth is 340 feet. The ore is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Davidson Ore Mining Co., Buffalo, N. Y.
Manager: T. F. Hildreth.
Superintendent: Rudolph Ericson.
Sales Agents: Davidson Ore Mining Co., Buffalo, N. Y.
See shipments of Davidson No. 1.
Analysis: See analyses of DAVIDSON, STERLING and CLIFTON.

DAVIDSON No. 3 MINE

Location: Iron county, Mich., Section 14, Township 43, Range 35.
Description: First opened up in 1920. This mine ships two grades of ore: DAVIDSON and STERLING, both soft, yellow nonbessemer limonites. The mine is worked by the back stoping and shrinkage systems, the greatest vertical depth being 230 feet. The ore is shipped via the C. & N. W. and the C. M. & St. P. railroads to Escanaba, Mich., and thence by boat to lower lake ports.
Operating Company: Davidson Ore Mining Co., Buffalo, N. Y.
Manager: T. F. Hildreth.
Superintendent: Rudolph Ericson.
Sales Agents: Davidson Ore Mining Co., Buffalo, N. Y.
Analysis: See analyses of DAVIDSON and STERLING.

DAVIDSON No. 4 MINE (Formerly Wapama or Purcell)

Location: Iron county, Mich., Section 14, Township 43, Range 35.
Description: First opened up in 1912. This mine ships two grades of ore: DAVIDSON and STERLING, both soft, yellow nonbessemer limonites. The mine is worked by the shrinkage system, the greatest vertical depth being 320 feet. The ore is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and thence by boat to lower lake ports.
Operating Company: Davidson Ore Mining Co., Buffalo, N. Y.
Manager: T. F. Hildreth.
Superintendent: Rudolph Ericson.
Sales Agents: Davidson Ore Mining Co., Buffalo, N. Y.
Analysis: See analyses of DAVIDSON and STERLING.

DUNN MINE

Location: Iron county, Mich., Section 1, Township 42, Range 33.

Description: First opened up in 1887. The ore is a soft, brown, nonbessemer hematite and is crushed. Underground system of mining is used. The ore is shipped via the C. & N. W. and the C., M. & St. P. railroad to Escanaba, Mich., and thence by boat to lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1887— 24,677 tons	1897— 31,062 tons	1907—141,992 tons
1888—118,096 tons	1898— 49,381 tons	1908— 8,829 tons
1889—151,828 tons	1899— 7,458 tons	1909—193,396 tons
1890—156,963 tons	1900—	1910—136,144 tons
1891—162,721 tons	1901—	1911—232,093 tons
1892—133,666 tons	1902— 2,816 tons	1912—242,304 tons
1893— 58,590 tons	1903— 5,365 tons	1913— 14,912 tons
1894— 24,538 tons	1904—	1914— 52,883 tons
1895— 90,885 tons	1905— 21,051 tons	1915— 8,304 tons
1896— 47,081 tons	1906— 91,476 tons	1916—

Total, tons 2,208,511

ERNST MINE

Location: Florence county, Wis., Section 27, Township 40, Range 18.

Description: First opened up in 1912. This mine ships two ores: ERNST No. 1 and ERNST No. 2, both soft, red nonbessemer hematites, crushed. The mine is worked by the rooming and milling systems, the greatest vertical depth being 500 feet. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: Florence Iron Co. of Wisconsin, Florence, Wis.

General Manager: Felix A. Vogel.

Superintendent: Ed. Larson.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1913—	1916— 74,879 tons	1919— 77,990 tons
1914— 40,437 tons	1917— 70,416 tons	
1915—124,765 tons	1918—173,155 tons	

Total, tons 561,642

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.
56.70	.262	5.87	.30	2.71	2.55	2.47	.317

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.03	51.01	.236	5.28

FAIRBANKS MINE (or Paint River Mine)

Location: Iron county, Mich., Section 20, Township 43, Range 32

Description: First opened up in 1882, but is now idle.

Yearly Shipments:

1882—	6,515	tons	1894—			1906—	28,321	tons
1883—	5,873	tons	1895—			1907—	75,805	tons
1884—	11,652	tons	1896—			1908—		
1885—	2,373	tons	1897—			1909—		
1886—	13,933	tons	1898—			1910—		
1887—	10,240	tons	1899—			1911—		
1888—	12,506	tons	1900—	1,316	tons	1912—		
1889—	32,700	tons	1901—			1913—	2,289	tons
1890—	62,654	tons	1902—	10,383	tons	1914—		
1891—	45,435	tons	1903—	9,863	tons	1915—		
1892—	18,390	tons	1904—	11,257	tons	1916—		
1893—			1905—	11,973	tons			

Total, tons 382,078

FLORENCE MINE

Location: Florence county, Wis., Sections 20 and 21, Township 40, Range 18.

Description: First opened up in 1880. The ore is a soft, red nonbessemer hematite and is crushed. The mine is worked by the milling and stoping system, the greatest vertical depth being 700 feet. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Florence Iron Co. of Wisconsin, Florence, Wis.

General Manager: Felix A. Vogel.

Superintendent: Ed. Larson.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

Prior to 1911—2,957,180 tons

1911—	95,266	tons	1915—	23,118	tons	1918—	97,322	tons
1912—	99,682	tons	1916—	28,240	tons	1919—	61,888	tons
1914—	680	tons	1917—	47,193	tons			

Total, tons 3,410,569

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.00	.288	5.91	.26	2.96	2.36	2.73	.310	4.34

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.09	50.35	.259	5.31

FOGARTY MINE

Location: Iron county, Mich., Section 1, Township 42, Range 35.

Description: First opened up in 1907. The ore, BALTIC, is a hard, red, nonbessemer hematite and is partially crushed. The mine is worked by the underground stoping system, the

greatest vertical depth being 565 feet. The ore is shipped via the C. & N. W. railway to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Verona Mining Co., Cleveland, O.
Assistant General Manager: W. P. Chinn.
General Superintendent: C. E. Lawrence.
Sales Agents: Pickands, Mather & Co., Cleveland, O.
Yearly Shipments:

1907— 7,949 tons	1912— 84,074 tons	1917— 37,291 tons
1908— 32,560 tons	1913—124,568 tons	1918— 24,979 tons
1909— 77,356 tons	1914— 15,329 tons	1919— 15,405 tons
1910— 51,071 tons	1915— 27,718 tons	
1911— 67,616 tons	1916— 89,506 tons	

Total, tons 655,422

Analysis: See analysis of OSANA.

FORBES MINE

Location: Iron county, Mich., Section 14, Township 43, Range 35.

Description: First opened up in 1912. The ore is a medium, yellow, nonbessemer hematite. The mine is worked by the open-stope, shrinkage-stope and top-slicing systems, the greatest vertical depth being 275 feet. The ore is shipped via the C. & N. W. and the C., M. & St. P. railways to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Jones & Laughlin Ore Co., Jones & Laughlin Bldg., Pittsburgh, Pa.

General Superintendent: C. T. Kruse.

Yearly Shipments:

1912—	1914— 77,960 tons	1916—121,010 tons
1913— 69.435 tons	1915— 99,050 tons	

Total, tons 367,455

Analysis: The expected analysis for 1920 is as follows:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.50	.472	3.95	.30	3.26	.79	.53	.029	9.63

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
7.12	52.48	.438	3.67

FORTUNE LAKE MINE

Location: Iron county, Mich., Sections 24, 25 and 26, Township 43, Range 33.

Description: Mine not yet opened. Considerable drilling has been done and a shaft partially sunk. Operations are suspended for the time being. The ore will be shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Fortune Lake Mining Co., Crystal Falls, Mich.
Manager: E. W. Hopkins.
Superintendent: R. A. Bowen.
Assistant Superintendent: A. Bjork.
Sales Agents: Oglebay, Norton & Co., Cleveland, O.

GENESEE MINE

Location: Iron county, Mich., Sections 29, 30 and 31, Township 43, Range 32 West.

Description: First opened up in 1902. The ore is soft, red non-bessemer hematite. Underground system of mining is used. The ore is crushed. It is shipped via the C. & N. W., and the C., M. & St. P. railroads to Escanaba, Mich., and from there by boat to the lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1902—	14,455 tons	1907—	38,984 tons	1912—	4,284 tons
1903—	61,694 tons	1908—		1913—	
1904—	132,380 tons	1909—	65,585 tons	1914—	
1905—	77,370 tons	1910—	66,185 tons	1915—	1,184 tons
1906—	80,971 tons	1911—	25,342 tons	1916—	

Total, tons 568,398

GROVELAND MINE

Location: Dickinson county, Mich., N. E. ¼ of S. E. ¼ and N. E. ¼ of S. W. ¼, Section 31, Township 42, Range 29

Description: First opened up in 1901, but is now idle.

Yearly Shipments:

Prior to 1901— 1,049 tons

1901—	11,444 tons	1906—		1911—	31,907 tons
1902—	7,599 tons	1907—	13,913 tons	1912—	14,320 tons
1903—	1,294 tons	1908—	9,123 tons	1913—	9,251 tons
1904—	4,737 tons	1909—	24,933 tons		
1905—		1910—	26,462 tons		

Total, tons 156,032

GIBSON MINE

Location: Iron county, Mich., Section 15, Township 44, Range 33.

Description: Opened up prior to 1892, but the mine is now closed.

Yearly Shipments:

Prior to 1908— 16,357 tons

1908—	4,548 tons	1910—	45,202 tons
1909—	36,242 tons	1911—	57,100 tons

Total, tons 159,453

GREAT WESTERN MINE

Location: Iron county, Mich., Section 21, Township 43, Range 32.

Description: First opened up in 1882. The ore is a soft, brown, nonbessemer hematite and is crushed. Underground system of mining is used. The ore is shipped via the C. & N. W. and the C., M. & St. P. railways to Escanaba, Mich., and thence by boat to the lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1882—	587	tons	1895—			1908—	124,246	tons
1883—	22,825	tons	1896—	14,643	tons	1909—	112,747	tons
1884—	20,710	tons	1897—			1910—	80,709	tons
1885—			1898—	33,851	tons	1911—	84,339	tons
1886—	22,267	tons	1889—	43,316	tons	1912—	3,342	tons
1887—	23,239	tons	1900—	98,550	tons	1913—	50,465	tons
1888—	21,860	tons	1901—	123,261	tons	1914—		
1889—	38,454	tons	1902—	42,470	tons	1915—	35,759	tons
1890—	72,546	tons	1903—	100,751	tons	1916—		
1891—	62,464	tons	1904—	68,318	tons	1917—	7,692	tons
1892—	87,478	tons	1905—	191,265	tons	1918—	63,449	tons
1893—	661	tons	1906—	311,218	tons	1919—	42	tons
1894—			1907—	234,492	tons			

Total tons 2,198,025

HEMLOCK MINE

Location: Iron county, Mich., Section 4, Township 44, Range 33.

Description: First opened up in 1889, but is now exhausted.

Yearly Shipments:

1889—			1900—	72,413	tons	1911—	107,752	tons
1890—			1901—	149,966	tons	1912—	126,132	tons
1891—	35,531	tons	1902—	123,331	tons	1913—	110,511	tons
1892—	65,459	tons	1903—	79,420	tons	1914—	46,449	tons
1893—	11,323	tons	1904—	136,232	tons	1915—	28,172	tons
1894—			1905—	124,450	tons	1916—	72	tons
1895—	949	tons	1906—	106,437	tons	1917—		
1896—	94,645	tons	1907—	117,181	tons	1918—	634	tons
1897—	96,032	tons	1908—	83,834	tons	1919—	734	tons
1898—	69,865	tons	1909—	112,481	tons			
1899—	110,269	tons	1910—	115,407	tons			

Total, tons 2,125,047

HIAWATHA MINE

Location: Iron county, Mich., S½ of the SW¼ Section 34, SE¼ of SE¼ and the SW¼ of SE¼ of Section 35, Township 43N. Range 35W.

Description: First opened up in 1906. This mine ships two grades of ore: HIAWATHA and STEGMILLER, both hard, red, nonbessemer hematites. The mine is worked by

the stoping method, the greatest vertical depth being 1264 feet. The ore is shipped via the C. & N. W. railway to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Munro Iron Mining Co., Iron River, Mich.
Manager: G. L. Woodworth.
Yearly Shipments:

Prior to 1908—210,683 tons

1908—138,190 tons	1912—220,106 tons	1916—187,070 tons
1909—136,739 tons	1913—160,510 tons	1917— 62,847 tons
1910—128,884 tons	1914— 91,369 tons	1918—126,962 tons
1911—116,736 tons	1915— 93,455 tons	1919— 86,136 tons

Total tons ..... 1,759,687 tons

HILL TOP AND VICTORIA MINE

Location: Iron county, Mich., Section 22, Township 43, Range 32.
Description: First opened up in 1912, but is now idle.
Operating Company: Joseph E. Thropp, Everett, Pa.
Manager: D. S. Thropp.

HOLLISTER MINE

Location: Iron county, Mich., Section 13, Township 43, Range 33.
Description: First opened up in 1890, but is now abandoned.
Yearly Shipments:

1890— 2,020 tons	1908— 10,671 tons	1912—
1891— 1,057 tons	1909— 25,842 tons	1913— 25,251 tons
1892— 1,021 tons	1910— 49,434 tons	1914— 16,429 tons
1907— 6,371 tons	1911— 5,021 tons	

Total, tons 143,117

HOMER MINE

Location: Iron county, Mich., Section 23, Township 43, Range 35.
Description: First opened up in 1914. The ore is a medium red-brown nonbessemer hematite. The mine is worked by the sub-stoping method, the greatest vertical depth being 660 feet. The ore is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Buffalo Iron Mining Co., Iron River, Mich.
Manager: E. C. Bowers.
Superintendent: H. E. Duff.
Yearly Shipments:

1914—	1916—161,286 tons	1918—213,059 tons
1915—103,546 tons	1917—202,351 tons	1919—205,254 tons

Total, tons 885,496

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.00	.399	7.35	.23	5.02	.61	.84	.050	6.87

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
9.22	49.91	.355	6.66

INDIANA MINE

Location: Dickinson county, Mich., Breitung Township.

Description: First opened up in 1882. This mine ships two grades of ore: INDIANA 1 and INDIANA 2, both hard, red, low-phosphorus hematite. The ore is crushed. The mine is worked by the open-pit milling system, the greatest vertical depth being 180 feet. This mine is said to produce lower phosphorus than any other in the Lake Superior region. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by rail to lower lake ports.

Operating Company: John M. Thomas, Milwaukee, Wis.

Manager: G. A. Richards.

Yearly Shipments:

1882—	4,280	tons	1886—	5,854	tons	1918—	58,401	tons
1883—	4,362	tons	1915—	52,570	tons	1919—	14,018	tons
1884—	636	tons	1916—	44,162	tons			
1885—	2,739	tons	1917—	46,480	tons			

Total, tons 233,502

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Indiana 1:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.
39.50	.007	37.45	.10	.78	1.66	1.35

Indiana 2:

36.80	.013	39.40	.12	.73	1.63	1.37

The ore in its natural state is as follows:

Indiana 1:

Moist.	Iron	Phos.	Silica
2.90	38.39	.007	36.40

Indiana 2:

3.00	35.73	.013	38.25

JUDSON MINE

Location: Iron county, Mich., Section 13, Township 42, Range 33.

Description: First opened up in 1913. This mine ships one grade of ore: JUDSON, a medium brick-red, nonbessemer hematite, and the ore is crushed. The mine is worked by the substoping system, the greatest vertical depth being 550 feet. The ore is shipped via the C. & N. W. and the C. M. & St. P. railroads to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Judson Mining Co., Alpha, Mich.

Manager: E. E. Hunner.

Superintendent: Alfred Martin.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

1914—	6,619 tons	1916—	162,519 tons	1918—	195,938 tons
1915—		1917—	60,235 tons	1919—	106,869 tons

Total, tons 532,180

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.18	.586	6.50	.60	3.31	2.05	1.90	.052	3.19

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
9.06	50.18	.533	5.91

KIMBALL MINE

Location: Iron county, Mich., Section 29, Township 43, Range 32.
Description: First opened up in 1906. The ore is a soft, red non-bessemer hematite. The underground system of mining is used. The ore is crushed. It is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and from there by boat to lower lake ports.
Sales Agents: The McKinney Steel Co., Cleveland, O.
Yearly Shipments:

1907—	16,224 tons	1911—		1915—	19,533 tons
1908—		1912—		1916—	
1909—		1913—			
1910—		1914—			

Total, tons 35,757

LAMONT MINE (Formerly Monitor)

Location: Iron county, Mich., Section 20, Township 43, Range 32.
Description: First opened up in 1889, but is now idle.

1889—	12,348 tons	1897—		1905—	74,991 tons
1890—	31,139 tons	1898—		1906—	89,980 tons
1891—	26,226 tons	1899—	67,652 tons	1907—	42,090 tons
1892—	42,819 tons	1900—	31,323 tons	1908—	
1893—	13,777 tons	1901—		1909—	
1894—	2,600 tons	1902—	47,267 tons	1910—	3,183 tons
1895—		1903—	43,736 tons		
1896—		1904—	29,393 tons		

Total, tons 558,524

LINCOLN MINE

Location: Iron county, Mich., Section 21, Township 43, Range 32 West.
Description: First opened up in 1891, but is now idle.
Yearly Shipments:

1891—	1,813 tons	1901—	19,727 tons	1906—	5,890 tons
1892—	26,019 tons	1902—	7,747 tons	1907—	714 tons
1893—	8,757 tons	1903—	15,606 tons	1908—	
1899—	43,622 tons	1904—	17,577 tons	1909—	1,657 tons
1900—	72,959 tons	1905—	19,539 tons		

Total, tons..... 241,627

LORETTO MINE

Location: Dickinson county, Mich., Section 7, Township 39, Range 28.

Description: First opened up in 1892. Two ores are shipped from this mine: LORETTO, a soft, blue bessemer hematite, and RUSSELL, a soft, blue nonbessemer hematite, both being crushed. The mine is worked by the top-slicing system, the greatest vertical depth being 900 feet. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Loretto Iron Co., 1400 Fulton St., Chicago.

Manager: J. Ward Amberg.

Superintendent: C. H. Baxter.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1893— 8,131 tons	1902—128,300 tons	1911— 18,655 tons
1894— 55,983 tons	1903— 87,939 tons	1912—136,045 tons
1895— 53,160 tons	1904— 54,720 tons	1913—158,257 tons
1896— 34,334 tons	1905—118,738 tons	1914— 45,449 tons
1897— 54,104 tons	1906—140,390 tons	1915— 68,806 tons
1898— 68,447 tons	1907— 99,779 tons	1916—174,173 tons
1899— 64,824 tons	1908— 13,345 tons	1917—193,950 tons
1900— 61,219 tons	1909— 96,613 tons	1918—155,891 tons
1901— 54,985 tons	1910—116,048 tons	1919— 82,259 tons

Total, tons 2,344,553

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Loretto:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.50	.020	7.37	.14	2.58	.78	.93	.008	1.65

Russell:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.07	.063	9.10	.16	2.60	1.55	4.32	.001	3.46

The ore in its natural state is as follows:

Loretto:

Moist.	Iron	Phos.	Silica
8.57	55.32	.018	6.74

Russell:

Moist.	Iron	Phos.	Silica
6.96	51.24	.059	8.47

MANSFIELD MINE

Location: Iron county, Mich., Sections 17 and 20, Township 43, Range 31.

Description: First opened up in 1890, but is now inactive.

Yearly Shipments:

1890—	18,303 tons	1900—	90,155 tons	1908—	44,633 tons
1891—	49,836 tons	1901—	74,113 tons	1909—	118,713 tons
1892—	69,259 tons	1902—	31,181 tons	1910—	114,357 tons
1893—	69,558 tons	1903—	51,440 tons	1911—	54,646 tons
1897—	37,182 tons	1904—	79,163 tons	1912—	
1898—	60,739 tons	1905—	38,584 tons	1913—	190,503 tons
1899—	86,607 tons	1907—	183,532 tons		

Total, tons 1,462,504

McDONALD MINE

Location: Iron county, Mich., Section 23, Township 43, Range 32

Description: First opened up in 1908, but is now idle.

Yearly Shipments:

1908—		1910—	6,022 tons	1912—	1,384 tons
1909—	1,144 tons	1911—	5,240 tons	1913—	16,499 tons

Total, tons 30,289

MICHIGAN MINE

Location: Iron county, Mich., Section 9, Township 44, Range 33.

Description: First opened up in 1893, but is now inactive.

Yearly Shipments:

1893—	505 tons	1901—		1909—	
1894—	77 tons	1902—	53,272 tons	1910—	17,922 tons
1895—	1,071 tons	1903—		1911—	
1896—		1904—		1912—	
1897—	216 tons	1905—	58,088 tons	1913—	27,917 tons
1898—		1906—	146 tons	1914—	9,471 tons
1899—		1907—	39,819 tons	1915—	112,680 tons
1900—		1908—	603 tons	1916—	28,483 tons

Total, tons 350,270

MILLIE MINE (Formerly Hewitt Mine)

Location: Dickonson county, Mich., Section 31, Township 40, Range 30.

Description: First opened up in 1880. This mine ships a soft, blue, siliceous bessemer hematite. The mine is worked by the open-cut and underground methods, the greatest vertical depth being 350 feet. The ore is shipped via the C. & N. W. railway to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Iron Mountain, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1881—	4,352	tons	1893—			1905—		
1882—	9,500	tons	1894—	13,062	tons	1906—	36,815	tons
1883—	7,516	tons	1895—	10,924	tons	1907—	18,691	tons
1884—	7,927	tons	1896—	21,815	tons	1908—	3,322	tons
1885—	4,627	tons	1897—	10,374	tons	1909—	10,887	tons
1886—	5,517	tons	1898—	17,430	tons	1910—		
1887—	1,163	tons	1899—	15,194	tons	1911—	17,040	tons
1888—	11,124	tons	1900—	14,922	tons	1912—	1,165	tons
1889—	12,274	tons	1901—	12,133	tons	1913—		
1890—	39,232	tons	1902—	25,935	tons	1914—	361	tons
1891—	5,889	tons	1903—	40,860	tons	1919—	6,391	tons
1892—	6,780	tons	1904—					

Total, tons 393,222

MONONGAHELA MINE

Location: Iron county, Mich., Section 36, Township 43, Range 33.

Description: First opened up in 1901 and reopened in 1915. The ore is a hard and soft, red, high-phosphorus, nonbessemer hematite. The mine is now only under development, no mining operations having been attempted as yet. The greatest vertical depth is 290 feet. The ore is shipped via the C., M. & St. P. railway and the C. & N. W. railway to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: Hollister Mining Co., Crystal Falls, Mich.

Manager: Earl E. Hunner.

General Superintendent: Alfred Martin.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1901—	2,397	tons	1915—			1918—	25,739	tons
1902—			1916—	21,922	tons	1919—	66,013	tons
1903—	6,913	tons	1917—					

Total tons 122,984

Analysis: See analysis of CARPENTER.

MUNRO MINE

Location: Dickinson county, Mich., NW¼ of SE¼ and the NE¼ of SW¼ of Section 6, Township 39N, Range 29W.

Description: First opened up in 1903. The ore is a hard, red siliceous hematite and is crushed. The mine is worked by the underground and open-pit methods, the greatest vertical depth being 150 feet. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: Munro Iron Mining Co., Iron River, Mich.

Yearly Shipments:

1903—	8,739	tons	1909—	23,241	tons	1915—		
1904—	32,323	tons	1910—	20,022	tons	1916—	17,621	tons
1905—	92,183	tons	1911—	9,303	tons	1917—	46,960	tons
1906—	47,454	tons	1912—	20,100	tons	1918—	53,031	tons
1907—	46,834	tons	1913—	18,508	tons	1919—	30,918	tons
1908—	27,773	tons	1914—					

Total, tons 495,019

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.
34.93	.045	37.05	.17	1.78	1.98	1.70

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
3.51	33.70	.043	35.75

NANAIMO MINE (Includes Former BETA)

Location: Iron county, Mich., Section 26, Township 43, Range 35.

Description: First opened up in 1882, but is now idle.

Yearly Shipments:

1882—	2,480	tons	1888—	5,744	tons	1906—	91,792	tons
1883—	29,221	tons	1890—	3,441	tons	1907—	53,778	tons
1884—	37,620	tons	1891—	13,200	tons	1908—	305	tons
1886—	5,400	tons	1904—	9,086	tons			
1887—	30,460	tons	1905—	91,238	tons			

Total, tons 373,765

ODGERS MINE

Location: Iron county, Mich , Section 30, Township 43, Range 32.

Description: First opened up in 1916. The ore is a soft, brown nonbessemer hematite, and is crushed. The underground system of mining is used. The ore is shipped via the C., M. & St. P. railroad to Escanaba, Mich., and thence by boat to lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1916—	53,177	tons	1918—	257,637	tons
1917—	169,668	tons	1919—	100,061	tons

Total, tons 580,543

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.91	.510	6.92	.32	1.76	2.10	2.40	.007	3.69

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
8.32	53.10	.468	6.34

OSANA MINE (Formerly James)

Location: Iron county, Mich., Section 23, Township 43, Range 35.

Description: This mine was re-opened in 1906. The ore is a soft, yellow, nonbessemer limonite. The mine is worked by the sub-level caving and stoping methods, the greatest vertical depth being 428 feet. The ore is shipped via the C. & N. W. railway to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Mineral Mining Co., Iron Mountain, Mich.

General Manager: E. F. Brown.

Superintendent: J. A. Monroe.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1907— 2,360	tons	1912— 75,702	tons	1917—171,001	tons
1908— 57,960	tons	1913—188,966	tons	1918—201,098	tons
1909— 90,851	tons	1914— 73,832	tons	1919—137,579	tons
1910— 78,388	tons	1915—121,655	tons		
1911— 50,439	tons	1916—167,115	tons		

Total tons 1,418,738

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
54.85	.463	7.55	.46	3.22	1.35	1.75	.03	6.20

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
9.00	49.91	.421	6.87

PENN MINES

(Including the Cyclops, Norway, West Vulcan, Curry and Brier Hill mines.)

Location: Dickinson county, Mich., Sections 5, 9, 10 and 11, Township 39, Range 29.

Description: First opened up in 1877. The mine ships six ores: CYCLOPS, a medium, blue, special bessemer hematite; VULCAN, a medium blue bessemer hematite; HARPER, a medium blue nonbessemer hematite; JUPITER, a hard, brown, siliceous bessemer hematite, and MARS, a hard, brown, siliceous nonbessemer hematite, BRIER HILL LUMP, a hard lumpy, brown hematite. The mines are worked by the top slicing, sub-level slicing and rooms with square sets and filling. The greatest vertical depth is 1,500 feet. The ore is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: Penn Iron Mining Co., Vulcan, Mich.

Manager: William Kelly.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

Cyclops

1878—	6,028 tons	1883—	22,675 tons	1888—	14,693 tons
1879—	46,158 tons	1884—	24,099 tons	1889—	6,101 tons
1880—	14,368 tons	1885—	49,897 tons	1890—	7,361 tons
1881—	12,644 tons	1886—	37,189 tons	1891—	10,599 tons
1882—	18,287 tons	1887—	14,297 tons	1892—	1,697 tons

Total, tons 286,093

Norway

1878—	7,276 tons	1883—	114,836 tons	1888—	87,260 tons
1879—	73,519 tons	1884—	71,710 tons	1889—	68,044 tons
1880—	198,165 tons	1885—	67,741 tons	1890—	61,717 tons
1881—	137,077 tons	1886—	93,878 tons	1891—	4,089 tons
1882—	165,547 tons	1887—	95,726 tons	1892—	44,767 tons

Total, tons 1,291,352

Vulcan

1877—	4,593 tons	1883—	79,874 tons	1889—	153,900 tons
1878—	38,799 tons	1884—	101,722 tons	1890—	104,996 tons
1879—	56,975 tons	1885—	124,125 tons	1891—	78,967 tons
1880—	86,976 tons	1886—	143,930 tons	1892—	179,904 tons
1881—	85,274 tons	1887—	205,036 tons		
1882—	94,042 tons	1888—	129,541 tons		

Total, tons 1,668,654

Curry

1879—	12,803 tons	1884—	10,079 tons	1889—	28,722 tons
1880—	21,851 tons	1885—	4,897 tons	1890—	72,162 tons
1881—	17,534 tons	1886—		1891—	100,681 tons
1882—	13,374 tons	1887—		1892—	125,773 tons
1883—	3,676 tons	1888—	5,376 tons		

Total, tons 416,928

Penn Iron Mining Co.

1893—	280,450 tons	1902—	273,443 tons	1911—	377,026 tons
1894—	175,274 tons	1903—	343,543 tons	1912—	429,150 tons
1895—	290,622 tons	1904—	141,948 tons	1913—	416,244 tons
1896—	179,917 tons	1905—	423,244 tons	1914—	203,478 tons
1897—	237,886 tons	1906—	496,582 tons	1915—	411,393 tons
1898—	223,713 tons	1907—	381,128 tons	1916—	427,266 tons
1899—	229,651 tons	1908—	176,211 tons	1917—	459,764 tons
1900—	197,606 tons	1909—	428,004 tons	1918—	210,632 tons
1901—	358,126 tons	1910—	344,760 tons	1919—	160,485 tons

Total, tons 8,277,566

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Cyclops:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
61.05	.013	8.11	.070	9.70	.54	.94	.022	...

Vulcan:								
55.80	.048	9.46	.27	1.30	1.56	3.40	.025	....
Harper:								
58.10	.104	8.90	.27	1.39	1.33	2.69	.020	2.40
Jupiter:								
41.17	.013	35.90	.36	.76	.54	.73	.018	....
Mars:								
41.06	.042	36.92	.08	1.02	.82	1.61	.011	....
Brier Hill:								
61.31	.081	5.68	.14	1.45	.85	2.01	.020	....

The ore in its natural state is as follows:

	Moist.	Iron	Phos.	Silica
Cyclops:	8.02	56.15	.012	7.46
Vulcan:	5.28	52.85	.046	8.96
Harper:	6.42	54.37	.097	8.33
Jupiter:	4.00	39.52	.013	34.46
Mars:	4.83	39.08	.040	35.14
Brier Hill:	6.15	57.54	.076	5.33

PEWABIC MINE

Location: Dickinson county, Mich., Section 32, Township 40, Range 30.

Description: First opened up in 1887, but operations ceased April 1, 1918.

Yearly Shipments:

1887— 1,740	tons	1898—305,072	tons	1909—465,453	tons
1888— 900	tons	1899—530,129	tons	1910—380,376	tons
1889— 9,614	tons	1900—374,043	tons	1911—352,608	tons
1890— 29,931	tons	1901—507,781	tons	1912—279,769	tons
1891— 68,402	tons	1902—530,291	tons	1913—364,176	tons
1892—115,273	tons	1903—489,175	tons	1914—299,228	tons
1893—165,745	tons	1904—372,791	tons	1915—178,013	tons
1894—304,010	tons	1905—533,413	tons	1916—301,125	tons
1895—262,551	tons	1906—493,891	tons	1917—153,256	tons
1896—273,587	tons	1907—457,796	tons	1918—113,999	tons
1897—279,855	tons	1908—365,341	tons		

Total, tons 9,359,339

PORTER MINE (Formerly Amasa Porter)

Location: Iron county, Mich., Section 22, Township 44, Range 33.

Description: First opened up in 1914. This mine ships two grades of ore: NEVADA and CEDAR, both medium brick-

red nonbessemer hematites. The mine is worked by the sub-stoping and top slicing systems, the greatest vertical depth being 696 feet. The ore is shipped via the C., M. & St. P. railroad to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Hemlock River Mining Co., Cleveland, O.
Assistant General Manager: W. P. Chinn.
General Superintendent: C. E. Lawrence.
Sales Agents: Pickands, Mather & Co., Cleveland, O.
Yearly Shipments:

1914—	1916— 80,492 tons	1918— 65,794 tons
1915—	1917—116,148 tons	1919— 46,802 tons

Total, tons 309,236

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Cedar:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.00	.156	9.57	.21	4.69	1.42	2.83	.018	2.27

The ore in its natural state is as follows:

Cedar:

Moist.	Iron	Phos.	Silica
8.70	50.22	.142	8.73

QUINNESEC MINE

Location: Dickinson county, Mich., Section 34, Township 40, Range 30.

Description: First opened up in 1878. The ore is a soft, blue, siliceous bessemer hematite. The ore is crushed, and is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and from there by boat to lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.
Yearly Shipments:

1878— 25,925 tons	1889— 761 tons	1900— 25,967 tons
1879— 41,954 tons	1890—	1901— 66,383 tons
1880— 52,436 tons	1891—	1902— 62,531 tons
1881— 43,711 tons	1892—	1903— 49,708 tons
1882— 44,240 tons	1893—	1904— 33 tons
1883— 21,676 tons	1894—	1906—
1884— 16,995 tons	1895—	1907—
1885— 14,110 tons	1896—	1908— 1,410 tons
1886— 13,442 tons	1897—	1909— 3,147 tons
1887— 6,585 tons	1898—	1910— 744 tons
1888— 2,249 tons	1889— 11,049 tons	

Total, tons 505,056

RANDVILLE MINE

Location: Dickinson county, Mich., Section 31, Township 42 N., Range 29 W.

Description: The mine at present is an exploration, having been drilled but not opened.

RAVENNA MINE

Location: Iron county, Mich., Section 19, Township 43, Range 32.

Description: First opened up in 1911, but is now idle.

Operating Company: The Hollister Mining Co., Crystal Falls, Mich.

Manager: James D. Ireland.

General Superintendent: Alfred Martin.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1912— 18,301 tons	1915—116,724 tons	1918—
1913— 70,763 tons	1916— 3,476 tons	1919—
1914— 49,309 tons	1917— 37,848 tons	

Total, tons 296,421

RICHARDS MINE

Location: Iron county, Mich., Section 36, Township 43, Range 33.

Description: First opened up in 1913. The ore is a soft, brown nonbessemer hematite, and is crushed. The underground system of mining is used. The ore is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and thence by boat to lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1913— 46,170 tons	1916— 29,382 tons	1919—111,116 tons
1914— 7,069 tons	1917— 43,890 tons	
1915— 92,808 tons	1918— 56,087 tons	

Total, tons 386,522

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.40	.590	6.12	.48	2.32	3.00	2.10	.008	3.78

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
8.65	51.52	.539	5.59

RIVERTON MINE

Location: Iron county, Mich., Sections 1, 2, 35 and 36, Townships 42 and 43, Range 35.

Description: First opened up in 1898. This mine ships two grades of ore: BARTON, a hard, brown nonbessemer hematite, and ISABELLA, a soft, brown nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 1,026 feet. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Iron River, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1898— 5,009 tons	1906—161,704 tons	1914—176,233 tons
1899— 13,242 tons	1907— 90,358 tons	1915—262,382 tons
1900—120,207 tons	1908— 47,073 tons	1916—174,992 tons
1901—119,860 tons	1909—171,200 tons	1917—
1902—215,850 tons	1910— 84,269 tons	1918—100,496 tons
1903— 97,633 tons	1911—198,589 tons	1919— 72,875 tons
1904— 81,543 tons	1912—177,496 tons	
1905— 82,611 tons	1913—160,818 tons	

Total, tons 3,519,027

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Isabella:

Iron	Phos.	Silica	Mang.
54.88	.548	8.47	.165

The ore in its natural state is as follows:

Isabella:

Moist.	Iron	Phos.	Silica
6.11	7.95	.615	7.95

ROGERS MINE

Location: Iron county, Mich., Section 29, Township 43N, Range 34W.

Description: First opened up in 1912. This mine ships four grades of ore: ROGERS-SWANSON, MANGO-SWANSON, ROGERS-SCHEIBLER and ROGERS-PAULSON, all hard, red nonbessemer hematites. The mine is worked by the caving system, the greatest vertical depth being 520 feet. The ore is shipped via the C. & N. W. railroad and the C., M. & St. P. railroads to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Munro Iron Mining Co., Iron River, Mich.

Manager: G. L. Woodworth.

Yearly Shipments:

1912—	1915— 53,158 tons	1918— 84,196 tons
1913—	1916— 81,842 tons	1919— 50,339 tons
1914— 27,080 tons	1917—117,323 tons	

Total, tons 413,938

Analysis: The expected analysis of Rogers ore for 1920 is as follows: Dried at 212 degrces Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
55.33	.350	5.98	.64	5.38	2.54	3.12	.06	6.65

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
9.84	49.89	.316	5.39

SPIES MINE

Location: Iron county, Mich., Section 24, Township 43, Range 35.

Description: First opened up in 1916. The ore is a soft, red nonbessemer hematite. The mine is worked by the underground milling system, the greatest vertical depth being 400 feet. The ore is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Iron River, Mich.

Manager: M. M. Duncan.

Superintendent: C. J. Stakel.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1916—		1918— 48,782	tons
1917— 6,310	tons	1919—113,434	tons

Total, tons 168,526

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.50	.502	5.59	.16	3.53	.54	.45	.095	7.74

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
7.50	52.26	.464	5.17

TOBIN MINE

Location: Iron county, Mich., Section 30, Township 43, Range 32.

Description: First opened up in 1901. The ore is soft, red nonbessemer hematite. Underground system of mining is used. The ore is crushed, and is shipped via the C. & N. W. and the C., M. & St. P. railroads to Escanaba, Mich., and from there by boat to the lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1901— 18,957	tons	1908—161,642	tons	1915— 18,624	tons
1902— 55,238	tons	1909—359,668	tons	1916—146,113	tons
1903— 45,386	tons	1910—235,812	tons	1917—188,590	tons
1904—113,669	tons	1911—308,457	tons	1918—202,775	tons
1905—166,529	tons	1912—319,318	tons	1919— 97,674	tons
1906—235,867	tons	1913—154,896	tons		
1907—237,781	tons	1914— 65,351	tons		

Total, tons 3,132,347

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.61	.510	7.10	.31	1.81	1.92	1.87	.009	3.05

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
8.30	52.83	.468	6.51

TULLY MINE

Location: Iron county, Mich., Section 36, Township 43, Range 35 West.

Description: First opened up in 1909. The ore is soft, red nonbessemer hematite. The underground system of mining is used. The ore is crushed and is shipped via the C. & N. W. railroad to Escanaba, Mich., and from there by boat to lower lake ports.

Sales Agents: The McKinney Steel Co., Cleveland, O.

Yearly Shipments:

1910—	2,726 tons	1914—	63,411 tons	1918—	125,087 tons
1911—	8,324 tons	1915—	242,049 tons	1919—	134,141 tons
1912—		1916—	236,302 tons		
1913—	16,650 tons	1917—	121,426 tons		

Total, tons 950,116

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.93	.410	6.90	.18	2.00	1.11	.73	.008	3.37

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
7.92	55.18	.378	6.35

VIRGIL MINE

Location: Iron county, Mich., Section 24, Township 43, Range 35.

Description: First opened up in 1912. The ore is medium, yellow-brown, nonbessemer hematite. The mine is worked by the sub-stoping system, the greatest vertical depth being 273 feet. The ore is shipped via the C. & N. W. and the C., M. & St. P. railways to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Wickwire Mining Co., Buffalo, N. Y.

Manager: E. C. Bowers.

Superintendent: Harry Duff.

Yearly Shipments:

1912—	2,996 tons	1914—	5,913 tons	1916—	36,307 tons
1913—	48,945 tons	1915—		1918—	40,321 tons

Total tons..... 174,803

VIVIAN MINE

Location: Dickinson county, Mich., Section 34, Township 40, Range 30 W.

Description: First opened up in 1902, but is now inactive.

Yearly Shipments.

1902—	40,384 tons	1906—	122,577 tons	1911—	5,971 tons
1903—	12,122 tons	1907—	48,493 tons	1912—	28,800 tons
1904—	81,345 tons	1908—	10,056 tons	1913—	27,177 tons
1905—	90,426 tons	1910—	14,827 tons		

Total, tons 482,187

WARNER MINE

Location: Iron county, Mich., Section 9, Township 44, Range 35.

Description: First opened up in 1916. The ore, CEDAR, is a hard, red and purple nonbessemer hematite. The mine is worked by the underground stoping system, the greatest vertical depth being 940 feet. The ore is shipped via the C., M. & St. P. railroad to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: Hemlock River Mining Co., Cleveland, O.

Assistant General Manager: W. P. Chinn.

General Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1916—	33,751 tons	1918—	78,855 tons
1917—	74,814 tons	1919—	77,028 tons

Total, tons 264,448

Analysis: See analyses of CEDAR ore.

WAUSECA (Formerly Konwinski)

Location: Iron county, Mich., Section 23, Township 43, Range 35.

Description: First opened up in 1906. The ore, JAMES, is a soft, red, nonbessemer hematite. The mine is worked by the sub-level caving and stoping system, the greatest vertical depth being 398 feet. The ore is shipped via the C. & N. W. railroad to the C. & N. W. docks at Escanaba,, Mich., and thence by boat to lower lake ports.

Operating Company: Mineral Mining Co., Iron Mountain, Mich.

General Manager: Elwin F. Brown.

Superintendent: J. A. Monroe.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1910—		1914—		1918—	42,187 tons
1911—	749 tons	1915—	19,360 tons	1919—	5,944 tons
1912—		1916—	30,470 tons		
1913—	12,377 tons	1917—			

Total, tons 111,087

WICKWIRE MINE

Location: Iron county, Mich., Section 35, Township 43 N, Range 35 W.

Description: First opened up in 1911, but is now idle.

Operating Company: Wickwire Mining Co., Iron River, Mich.

Yearly Shipments:

1911—	1,919 tons	1914—	25,329 tons	1917—	242 tons
1912—	40,417 tons	1915—			
1913—	47,697 tons	1916—	13,265 tons		

Total tons 129,111

YOUNGS MINE

Location: Iron county, Mich., Section 12, Township 42, Range 35.

Description: First opened up in 1904, but has not been in operation since 1917.

Operating Company: G. W. Youngs Mining Co., Iron River, Mich.

Manager: F. W. Youngs.

Yearly Shipments:

1904—			1909—154,150	tons	1914—		
1905—	10,926	tons	1910— 98,399	tons	1915—		
1906—	47,583	tons	1911— 89,451	tons	1916—	53,691	tons
1907—	92,632	tons	1912— 83,528	tons	1917—	23,197	tons
1908—	70,094	tons	1913— 44,091	tons	1918—	2,601	tons

Total, tons 770,343

ZIMMERMAN MINE

Location: Iron county, Mich., Section 7, Township 42, Range 34.

Description: First opened up in 1907. The ore is a soft, red, nonbessemer hematite. The mine is 350 feet deep. The ore is shipped via the C. & N. W. railway to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Marting Ore Co., Gaastoa, Mich.

Manager: J. S. Lutes.

Superintendent: E. J. Looney.

Sales Agents: Tod-Stambaugh Co., Cleveland, O.

Yearly Shipments:

1908—	1,832	tons	1912—189,482	tons	1916—145,716	tons
1909—	10,303	tons	1913—150,817	tons	1917—219,902	tons
1910—	25,555	tons	1914—172,720	tons	1918—145,217	tons
1911—	112,029	tons	1915—108,217	tons	1919—198,649	tons

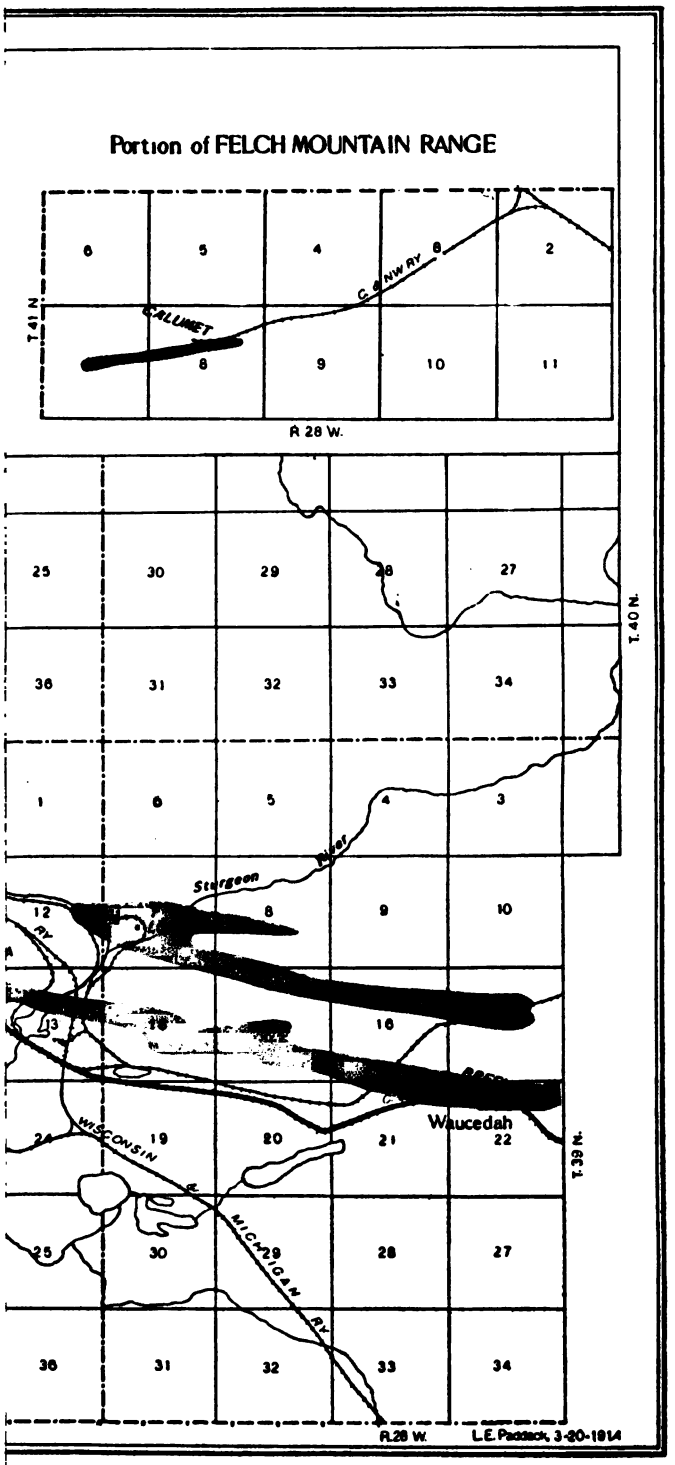
Total tons 1,480,439

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.00	.535	8.70	.18	4.30	1.25	.60	.112	4.00

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
9.46	50.70	.484	7.88


Portion of FELCH MOUNTAIN RANGE
T.41 N.
CALUMET
C. & NW RY.
R 28 W.
T. 40 N.
Sturgeon River
Waucedah
WISCONSIN & MICHIGAN RY.
T.39 N.
R.28 W.
L.E. Paddock, 3-20-1914

MARQUETTE RANGE

ADAMS MINE (American Mining Co.)

Location: Marquette county, Mich., South 2/3 of part of old right of way of D. S. S. & A. Railway Co. across S. W. ¼ of S. W. ¼ of Section 32, Township 48 N. W. ¼ of N. W. ¼ of Section 5, N. W. ¼ of Section 6, Township 47, Range 26.

Description: First opened up in 1913. The ore, REXFORD, is a soft, red, nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 650 feet. The ore is shipped via the Lake Superior & Ishpeming railroad to Marquette, Mich., and thence by boat to the lower lake ports.

Operating Company: Cleveland-Cliffs Iron Co., Cleveland, O.

Superintendent: G. J. Jackson.

Yearly Shipments:

1913—	1,504 tons	1916—	7,820 tons	1919—	33,615 tons
1914—		1917—	22,560 tons		
1915—	800 tons	1918—	32,924 tons		

Total, tons 99,223

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.
59.36	.082	8.07	.35

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
11.90	52.30	.072	7.11

AMERICAN MINE

Location: Marquette county, Mich., Section 32, Township 48, Range 28.

Description: This mine was opened in 1880, and re-opened in 1906. The ore, AMERICAN CRUSHED, is a soft, red bessemer hematite, with a small amount of specular. The mine is worked by the caving method, the greatest vertical depth being 1,850 feet. The ore is shipped via the C. & N. W. and the D., S. S. & A. railroad to Marquette and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The American-Boston Mining Co., Diorite,, Mich.

Manager: J. R. Thompson.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1880—	797	tons	1891—	21,604	tons	1913—	162,253	tons
1881—	4,702	tons	1892—	15,076	tons	1914—	85,093	tons
1882—	8,006	tons	1906—	419	tons	1915—	87,514	tons
1883—	3,618	tons	1907—	13,764	tons	1916—	245,969	tons
1884—	2,916	tons	1908—	23,222	tons	1917—	142,526	tons
1887—	1,483	tons	1909—	90,001	tons	1918—	120,756	tons
1888—	13,699	tons	1910—	163,290	tons	1919—	72,228	tons
1889—	21,000	tons	1911—	194,979	tons			
1890—			1912—	133,306	tons			

Total, tons 1,648,253

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.72	.029	11.97	.08	2.44	.54	.48	.014	.76

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
7.08	54.56	.027	11.12

ANGELINE MINE

Location: Marquette county, Mich., Section 15, Township 47, Range 27.

Description: First opened up in 1864. The ore is a soft, red bessemer hematite. The mine is worked by the underground and open-pit system, the greatest vertical depth being 800 feet. The ore is shipped via the L., S. & I., D., S. S. & A. and C. & N. W. railroads to Presque Isle and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming.

Manager: M. M. Duncan.

Superintendent: Lucien Eaton.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1864—	19,500	tons	1883—	27,259	tons	1902—	304,125	tons
1865—	20,151	tons	1884—	86,922	tons	1903—	310,950	tons
1866—	24,073	tons	1885—	111,051	tons	1904—	262,486	tons
1867—	46,607	tons	1886—	131,731	tons	1905—	374,183	tons
1868—	26,651	tons	1887—	191,120	tons	1906—	269,116	tons
1869—	39,694	tons	1888—	223,600	tons	1907—	283,373	tons
1870—	50,205	tons	1889—	229,070	tons	1908—	220,410	tons
1871—	33,645	tons	1890—	261,681	tons	1909—	276,749	tons
1872—	35,221	tons	1891—	241,605	tons	1910—	244,923	tons
1873—	43,933	tons	1892—	287,517	tons	1911—	167,258	tons
1874—	31,526	tons	1893—	351,973	tons	1912—	151,910	tons
1875—	26,370	tons	1894—	355,453	tons	1913—	104,357	tons
1876—	22,539	tons	1895—	313,555	tons	1914—	128,073	tons
1877—	19,113	tons	1896—	342,251	tons	1915—	19,513	tons
1878—	28,161	tons	1897—	489,685	tons	1916—		
1879—	25,321	tons	1898—	460,333	tons	1917—	54,673	tons
1880—	14,928	tons	1899—	464,988	tons	1918—	50,947	tons
1881—	18,060	tons	1900—	389,128	tons	1919—	36,473	tons
1882—	14,326	tons	1901—	481,574	tons			

Total, tons 9,240,038

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Angeline Bessemer:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.80	.047	8.80	.17	.15	.25	.07	.015	3.00

Angeline Nonbessemer:

60.20	.058	8.20	.20	.60	.27	.17	.012	4.73

The ore in its natural state is as follows:

Angeline Bessemer:

Moist.	Iron	Phos.	Silica
10.94	54.15	.042	7.84

Angeline Nonbessemer:

10.50	53.88	.052	7.34

ATHENS MINE

Location: Marquette county, Mich, Section 6, Township 47, Range 26.

Description: Developments commenced in 1913. The ore is a hematite, and is shipped via the L., S. & I. railroad.

Operating Company: The Athens Mining Co., Negaunee, Mich.

Manager: M. M. Duncan.

Superintendent: G. R. Jackson.

Sales Agents: Cleveland-Cliffs Iron Co. and Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1918— 20,923 tons 1919— 74,500 tons

Total, tons 95,423

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.80	.130	7.83	.52	2.82	.74	.63	.015	1.57

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
13.00	52.03	.113	6.81

AUSTIN MINE

Location: Marquette county, Mich., Section 20, Township 45, Range 25.

Description: First opened up in 1903. This mine ships two grades of ore: AUSTIN BESSEMER, a soft, red, bessemer hematite, and AUSTIN NONBESSEMER, a soft, red nonbessemer hematite. The mine is worked by the caving system, the greatest vertical depth being 364 feet. The ore is shipped via the M., M. & S. E. railroad to Presque Isle and C. & N. W. railroad to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Gwinn, Mich.

Manager: M. M. Duncan.

Superintendent: W. W. Graff.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1907—195,950 tons	1912—102,530 tons	1917— 44,421 tons
1908—111,229 tons	1913—107,366 tons	1918— 8,533 tons
1909—125,858 tons	1914— 30,493 tons	1919— 2,334 tons
1910—188,588 tons	1915—	
1911—105,078 tons	1916— 64,521 tons	

Total, tons 1,086,901

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Austin Bessemer:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.40	.044	9.76	.41	.50	.83	.18	.015	1.28

Austin Nonbessemer:

60.45	.472	6.35	.89	1.00	1.92	.57	.023	1.43

The ore in its natural state is as follows:

Austin Bessemer:

Moist.	Iron	Phos.	Silica
14.50	51.64	.038	8.34

Austin Nonbessemer:

14.50	51.68	.404	5.43

BARNES-HECKER MINE

Location: Marquette county, Mich., Section 2, Township 47, Range 28.

Description: First opened up in 1918, but not yet in operation. The greatest vertical depth is 1,067 feet. The ore will be shipped via the L. S. & I. railroad to Presque Isle, and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: J. M. Bush.

Sales Agents: Cleveland-Cliffs Iron Co., Cleveland, O.

BEAUFORT MINE (Formerly Ohio Mine)

Location: Baraga county, Mich., Section 22, Township 48, Range 31W.

Description: First opened up in 1881. The mine has been idle since 1918. Shipments since then were from stockpile ore.

Operating Company: Munro Mining Co.

Yearly Shipments:

1882— 5,532 tons	1903—134,648 tons	1912—
1883— 18,976 tons	1904— 25,781 tons	1913—
1884— 18,360 tons	1905— 38,306 tons	1914—
1885— 17,166 tons	1906—	1915— 21,139 tons
1886— 17,354 tons	1907— 78,029 tons	1916— 40,009 tons
1887— 12,829 tons	1908— 61,035 tons	1917—108,901 tons
1900— 1,583 tons	1909— 72,987 tons	1918— 3,229 tons
1901— 4,338 tons	1910— 23,427 tons	1919— 62,559 tons
1902— 59,781 tons	1911— 2,684 tons	

Total, tons 828,653

BESSIE MINE

Location: Marquette county, Mich., Section 35, Township 48, Range 29.

Description: First opened up in 1890 but is now inactive. The ore was a soft, brown nonbessemer hematite and limonite.

Yearly Shipments:

1891— 847 tons	1903— 29,718 tons	1906— 1,646 tons
1892 to 1901—	1904—	
1902— 5,007 tons	1905— 21,879 tons	

Total, tons 59,097

BREITUNG HEMATITE No. 1

Location: Marquette county, Mich., Sections 5 and 6, Township 47 N., Range 26 W.

Description: First opened up in 1901. This mine ships six ores: FOLEY No. 1, FOLEY No. 2 and BESSEMER, all soft, red and blue, bessemer hematites; MARY and CHARLOTTE, soft, red, nonbessemer hematites, and BREITUNG SILICEOUS, a soft, red, bessemer siliceous hematite. The mine is worked by the caving method, the greatest vertical depth being 960 feet. The ore is shipped via the D., S. S. & A. and L., S. & I. railroads to the D., S. S. & A. and L., S. & I. docks at Marquette, Mich., and thence by boat to lower lake ports.

Operating Company: Brietung Hematite Mining Co., Ltd., Negaunee, Mich.

Manager: C. B. Dunster, Cleveland, O.

Sales Agents: E. N. Breitung & Co., Cleveland, O.

Yearly Shipments: For Breitung Hematite Nos. 1 and 2.

1903— 7,854 tons	1910—114,202 tons	1916—153,607 tons
1904— 9,869 tons	1911—139,582 tons	1917—191,952 tons
1906— 38,671 tons	1912—122,320 tons	1918—195,428 tons
1907— 59,667 tons	1913—104,757 tons	1919— 78,464 tons
1908— 55,849 tons	1914— 77,574 tons	
1909—129,673 tons	1915—152,063 tons	

Total, tons 1,631,532

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

	Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
Foley:	60.60	.026	8.93	.26	2.39	.44	.19	.008	1.28
Mary:	59.42	.104	8.93	.20	2.76	1.01	.90	.088	1.00
Charlotte:	54.90	.094	14.56	.22	2.76	1.02	1.01	.083	1.72
Bessemer:	59.00	.040	8.53	.18	2.80	.50	.75	.137	1.17
Breitung Siliceous:	43.00	.033	34.00	.84	2.24	1.68	.12	.008	1.58

The ore in its natural state is as follows:

	Moist.	Iron	Phos.	Silica
Foley:	11.36	53.72	.023	7.92
Mary:	13.97	51.12	.089	7.68
Charlotte:	13.28	47.60	.082	12.62
Bessemer:	13.70	50.91	.034	7.36
Breitung Siliceous:	6.00	40.42	.031	31.96

BREITUNG HEMATITE No. 2 MINE

Location: Marquette county, Mich., Section 8, Township 47 N., Range 26 W.

Description: First opened up in 1905. This mine ships two ores: MARY and CHARLOTTE, both soft, red, nonbessemer hematites. The ore is hoisted through the Mary Charlotte No. 2 shaft. The mine is worked by the caving and stoping systems, the greatest vertical depth being 640 feet. The ore is shipped via the D., S. S. & A railroad and the L., S. & I. railroad to Marquette, Mich., and the C. & N. W. railroad to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: Brietung Hematite Mining Co., Ltd., Negaunee, Mich.

Manager: C. B. Dunster, Cleveland, O.

Superintendent: W. P. Pattison, Negaunee, Mich.

Sales Agents: E. N. Breitung & Co., Cleveland, O.

For shipments, see Breitung No. 1.

Analysis: See analyses of MARY and CHARLOTTE ores.

CAMBRIA MINE

Location: Marquette county, Mich., Section 35, Township 48, Range 27.

Description: First opened up in 1875. This mine ships two grades of ore, CAMBRIA and VIOLET, both semihard, brown bessemer and nonbessemer hematites. The mine is worked by the stoping and subbing systems, the greatest vertical depth being 1,300 feet. The ore is shipped via the C. & N. W. and the D. S. S. & A. railroads to Escanaba, and Marquette, respectively, and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, O.

Manager: F. J. Webb.

Superintendent: A. C. Hansen.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1875—	2,610 tons	1890—	80,359 tons	1905—	81,791 tons
1876—	6,329 tons	1891—	34,662 tons	1906—	40,628 tons
1877—	10,085 tons	1892—	41,549 tons	1907—	135,145 tons
1878—	3,754 tons	1893—	30,445 tons	1908—	85,977 tons
1879—	6,724 tons	1894—	47,218 tons	1909—	136,815 tons
1880—	6,958 tons	1895—	41,656 tons	1910—	150,422 tons
1881—	19,246 tons	1896—	95,086 tons	1911—	90,316 tons
1882—	64,545 tons	1897—	110,648 tons	1912—	69,904 tons
1883—	47,508 tons	1898—	102,623 tons	1913—	169,473 tons
1884—	59,742 tons	1899—	124,930 tons	1914—	132,814 tons
1885—	50,796 tons	1900—	80,432 tons	1915—	159,444 tons
1886—	58,784 tons	1901—	68,907 tons	1916—	195,612 tons
1887—	41,136 tons	1902—	63,976 tons	1917—	114,031 tons
1888—	57,865 tons	1903—	41,168 tons	1918—	144,462 tons
1889—	72,780 tons	1904—	84,852 tons	1919—	91,008 tons

Total, tons 3,354,055

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Cambria:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.75	.107	10.10	.28	3.40	.70	.43	.018	3.35

Violet:

57.75	.052	9.67	.22	3.10	.80	.49	.015	3.10

The ore in its natural state is as follows:

Cambria:

Moist.	Iron	Phos.	Silica
10.75	50.65	.096	9.01

Violet:

9.81	52.09	.047	8.72

CHAMPION MINE

Location: Marquette county, Mich., Sections 31 and 32, Township 48, Range 29.

Description: First opened up in 1867. The ore is a hard, blue

nonbessemer hematite. The mine is underground, the greatest vertical depth being 2314 feet. It is now inactive.

Yearly Shipments:

1867—	500 tons	1882—159,009	tons	1897—141,728	tons
1868—	6,225 tons	1883—104,960	tons	1898—163,190	tons
1869—	19,458 tons	1884—210,180	tons	1899—215,074	tons
1870—	73,161 tons	1885—173,915	tons	1900—113,743	tons
1871—	41,625 tons	1886—137,593	tons	1901— 69,026	tons
1872—	68,405 tons	1887—146,330	tons	1902—205,721	tons
1873—	72,782 tons	1888—174,680	tons	1903— 74,238	tons
1874—	46,769 tons	1889—215,098	tons	1904— 174	tons
1875—	57,979 tons	1890—223,442	tons	1905— 64,680	tons
1876—	66,002 tons	1891—133,413	tons	1906—145,007	tons
1877—	70,883 tons	1892—109,979	tons	1907—107,577	tons
1878—	73,464 tons	1893— 61,648	tons	1908— 313	tons
1879—	94,027 tons	1894— 42,788	tons	1909— 11,199	tons
1880—	112,401 tons	1895—100,398	tons	1910— 18,746	tons
1881—	145,427 tons	1896—113,375	tons		

Total, tons 4,413,131

CHASE MINE

Location: Marquette county, Mich., Section 3, Township 47, Range 28.

Description: First opened up in 1910, but was abandoned in 1915.

Yearly Shipments:

1910—		1913— 52,930	tons	1916— 72,354	tons
1911—		1914— 19,708	tons		
1912—		1915— 39,509	tons		

Total, tons 184,501

CLIFF SHAFT MINE

Location: Marquette county, Mich., Sections 9 and 10, Township 47, Range 27.

Description: First opened up in 1881. This mine ships two grades of ore: LUMP CLIFF SHAFT, and CRUSHED CLIFF SHAFT, both hard, red, nonbessemer specular. The mine is worked as an open stope, room and pillar. The greatest vertical depth is 1047 feet. The ore is shipped via the L., S. & I., C. & N. W. and D., S. S. & A. railways to Presque Isle and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: L. Eaton.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.
Yearly Shipments:

Cliff Shaft

1887— 87,346 tons	1890—188,776 tons	1893—130,812 tons
1888— 78,520 tons	1891—278,270 tons	1894—253,760 tons
1889—134,616 tons	1892—289,395 tons	1895—259,042 tons

Cleveland-Cliffs Group

1896— 513,119 tons	1904— 743,263 tons	1912—1,004,684 tons
1897— 718,408 tons	1905—1,288,416 tons	1913— 997,520 tons
1898— 869,482 tons	1906—1,330,944 tons	1914— 673,160 tons
1899—1,011,048 tons	1907—1,030,928 tons	1915— 634,837 tons
1900— 881,021 tons	1908— 438,379 tons	1916—1,036,775 tons
1901— 860,484 tons	1909— 877,433 tons	1917— 946,410 tons
1902—1,104,864 tons	1910— 955,374 tons	1918—1,050,147 tons
1903— 810,845 tons	1911— 344,950 tons	1919— 437,475 tons

Total, tons 30,368,590

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Lump Cliff Shaft:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.85	.098	5.38	.77	2.56	1.75	1.19	.011	2.53

Crushed Cliff Shaft:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.43	.100	6.71	.73	2.58	1.63	1.18	.008	3.14

The ore in its natural state is as follows:

Lump Cliff Shaft:

Moist.	Iron	Phos.	Silica
.50	59.55	.097	5.35

Crushed Cliff Shaft:

Moist	Iron	Phos.	Silica
2.20	57.14	.098	6.56

EMPIRE MINE

Location: Marquette county, Mich., Section 19, Township 47, Range 26.

Description: First opened up in 1907. The ore is a hard, brown, siliceous hematite. This ore is shipped as RICHMOND. The mine is worked by the open-pit milling system, the greatest vertical depth being 200 feet. The ore is shipped via the C. & N. W. railway to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Richmond Iron Co., Palmer, Mich.
Manager: E. E. Hunner.
Superintendent: John Huhtala.
Sales Agents: M. A. Hanna & Co., Cleveland, O.
Yearly Shipments:

1907— 40,565 tons	1911— 17,117 tons	1915—
1908— 53,537 tons	1912— 32,933 tons	1916— 47,110 tons
1909—108,993 tons	1913— 38,534 tons	1917— 38,392 tons
1910— 53,687 tons	1914—	1918— 45,947 tons

Total, tons 476,815

Analysis: See analysis of RICHMOND ore.

FRANCIS MINE

Location: Marquette county, Mich., Section 27, Township 45, Range 25.

Description: Developments commenced in 1913. Caving system of mining is used. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Gwinn, Mich.

Manager: M. M. Duncan.

Superintendent: W. W. Graff.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1918— 30,774 tons 1919— 26,936 tons

Total, tons 57,710

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
56.95	.261	6.75	.52	4.36	1.20	1.76	.072	2.73

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
15.20	48.29	.221	5.72

GARDNER MINE

Location: Marquette county, Mich., Section 35, Township 45, Range 25.

Description: Developments commenced in 1911. The greatest vertical depth of the mine is 860 feet. The ore is shipped via the C. & N. W. railroad.

Operating Company: The Cleveland-Cliffs Iron Co., Gwinn, Mich.

Manager: M. M. Duncan.

Superintendent: W. W. Graff.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Analysis: See analysis of MACKINAW.

GWINN MINE

Location: Marquette county, Mich., Section 28, Township 45, Range 25.

Description: First opened up in 1907. This mine ships three grades of ore: GWINN BESSEMER, a soft, red bessemer hematite, and GWINN, a soft, red nonbessemer hematite. The mine is worked by the caving system, the greatest vertical depth being 1,180 feet. The ore is shipped via the M., M. & S. E. and the C. & N. W. railroads to Presque Isle and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company. The Cleveland-Cliffs Iron Co., Gwinn, Mich.
Manager: M. M. Duncan.
Superintendent: W. W. Graff.
Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.
Yearly Shipments:

1911—	197 tons	1914—	20,158 tons	1917—	188,070 tons
1912—		1915—	57,910 tons	1918—	182,540 tons
1913—		1916—	143,708 tons	1919—	66,666 tons

Total, tons 769,985

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Gwinn Bessemer:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.30	.047	7.28	.27	1.81	.89	1.47	.052	2.05

Gwinn:

57.75	.224	9.10	.25	1.70	1.27	1.32	.058	2.00

The ore in its natural state is as follows:

Gwinn Bessemer:

Moist.	Iron	Phos.	Silica
9.50	54.58	.043	6.59

Gwinn:

11.26	51.25	.199	8.08

HARTFORD MINE

Location: Marquette county, Mich., Section 36, Township 48, Range 27.

Description: First opened up in 1899. This shaft is operated as the Cambria mine by the Republic Iron & Steel Co., Youngstown, O.

Yearly Shipments:

1889—	566 tons	1897—		1904—	179,980 tons
1890—		1898—		1905—	322,209 tons
1891—		1899—		1906—	364,801 tons
1892—	5,678 tons	1900—		1907—	328,161 tons
1893—	6,513 tons	1901—		1908—	278,366 tons
1894—	940 tons	1902—	7,440 tons	1909—	250,680 tons
1896—	1,532 tons	1903—	20,085 tons	1910—	183,471 tons

Total, tons 1,950,422

Analysis: See analysis of Cambria.

HIMROD MINE

Location: Marquette county, Mich., Section 7, Township 47 N., Range 26 W.

Description: First opened up in 1873. This mine ships three ores: BESSEMER, a soft, red and blue bessemer hematite; MARY, and CHARLOTTE, both soft, red and blue, non-bessemer hematites. The ore is hoisted through Mary Charlotte Shaft No. 2. The caving and stoping systems of min-

ing are used. The greatest vertical depth is 640 feet. The ore is shipped via the D., S. S. & A. and the L. S. & I. railroads to Marquette, Mich., and the C. & N. W. railroad to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: Mary Charlotte Mining Co., Negaunee, Mich.

Manager: C. B. Dunster, Cleveland, O.

Superintendent: W. B. Pattison, Negaunee, Mich.

Sales Agents: E. N. Breitung & Co., Cleveland, O.

Analysis: See analyses of BESSEMER, MARY and CHARLOTTE ores.

HOLMES MINE

Location: Marquette county, Mich., Section 9, Township 47, Range 27.

Description: First opened up in 1915. This mine produces four grades of ore: HOLMES BESSEMER and HOLMES NONBESSEMER, both hard, steel-blue specular ores; JUNCTION BESSEMER and JUNCTION NONBESSEMER, both hard, red, specular ores. Holmes grades are crushed and screened. The mine is worked by the caving system, the greatest vertical depth being 1,266 feet. The ore is shipped via the L. S. & I., C. & N. W. and the D. S. S. & A. railroads to Presque Isle, and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: L. Eaton.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1915— 17,373 tons	1917— 53,726 tons	1919— 47,804 tons
1916— 3,379 tons	1918—117,960 tons	

Total, tons 240,242

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

	Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
Holmes Bessemer:	61.65	.029	7.99	.15	2.24	.20	.34	.014	1.00
Holmes:	62.00	.068	7.55	.07	2.22	.14	.14	.021	1.50
Junction Bessemer:	66.30	.020	2.60	.07	1.57	.26	.16	.010	.50
Junction:	57.35	.107	7.95	.26	2.68	.24	.28	.015	2.87

The ore in its natural state is as follows:

	Moist.	Iron	Phos.	Silica
Holmes Bessemer:	3.00	59.80	.028	7.75
Holmes:	2.85	60.23	.066	7.33
Junction Bessemer:	8.00	66.30	.020	2.60
Junction:	8.00	52.76	.098	7.31

IMPERIAL MINE

Location: Baraga county, Mich., Section 25, Township 48, Range 31.

Description: First opened up in 1882, but operations were suspended in 1911. The lease of this mine was surrendered by the Cleveland-Cliffs Iron Co., April 1, 1919 to Michigan Iron & Land Co. The greatest vertical depth is 195 feet.

Yearly Shipments:

1890—	38,460	tons	1904—	727	tons	1909—	115,478	tons
1891—	18,552	tons	1905—	1,661	tons	1910—	83,404	tons
1892—	7,194	tons	1906—	5,076	tons	1911—	84,843	tons
1899—	23,235	tons	1907—	55,756	tons	1912—	54,053	tons
1900—	62,321	tons	1908—	48,231	tons	1913—	37,542	tons

Total, tons 636,533

ISABELLA MINE

Location: Marquette county, Mich., Sections 29 and 32, Township 47, Range 26.

Description: First opened up in 1912. This mine ships two grades of ore: ISABELLA, a soft, red bessemer hematite and SNYDER, a soft, red nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 900 feet. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Cascade Mining Co., 709 Security Bank Bldg., Minneapolis, Minn.

General Manager: O. B. Warren.

Superintendent: Thos. J. Nocholas.

Sales Agents: Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1912—			1915—	36,255	tons	1918—	80,691	tons
1913—			1916—	98,683	tons	1919—	39,197	tons
1914—			1917—	67,708	tons			

Total, tons 322,534

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Snyder:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
57.46	.060	12.80	.15	2.64	.27	.25	.018	1.20

Isabella:

54.88	.548	8.47	.17

The ore in its natural state is as follows:

Snyder:

Moist.	Iron	Phos.	Silica
10.00	51.71	.054	11.52

Isabella:

6.11	51.52	.515	7.95

JACKSON MINE

Location: Marquette county, Mich., Section 1, Township 47, Range 27.

Description: First opened up in 1848. This mine ships one grade of ore, SOUTH JACKSON, a hard, red, manganiferous hematite, crushed. The mine is worked by the open-pit system, the greatest vertical depth being 225 feet. The ore is shipped via the L. S. & I. and the C. & N. W. railroads to Presque Isle and Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: **G. R. Jackson.**

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments: North and South Jackson Mines.

Prior to 1857— 28,463 tons

1857—	12,442 tons	1878—	83,121 tons	1899—	88,230 tons
1858—	10,309 tons	1879—	112,921 tons	1900—	31,714 tons
1859—	28,377 tons	1880—	120,622 tons	1901—	38,271 tons
1860—	41,295 tons	1881—	118,939 tons	1902—	15,449 tons
1861—	12,919 tons	1882—	96,830 tons	1903—	5,409 tons
1862—	46,096 tons	1883—	71,278 tons	1904—	
1863—	77,237 tons	1884—	83,251 tons	1905—	33,180 tons
1864—	83,905 tons	1885—	68,657 tons	1906—	5,066 tons
1865—	65,505 tons	1886—	89,370 tons	1907—	61,345 tons
1866—	92,287 tons	1887—	109,606 tons	1908—	
1867—	127,491 tons	1888—	101,909 tons	1909—	11,060 tons
1868—	130,524 tons	1889—	128,891 tons	1910—	40,320 tons
1869—	125,908 tons	1890—	124,682 tons	1911—	52,615 tons
1870—	127,642 tons	1891—	92,979 tons	1912—	50,166 tons
1871—	138,297 tons	1892—	92,567 tons	1913—	1,519 tons
1872—	119,910 tons	1893—	51,009 tons	1914—	20,241 tons
1873—	130,131 tons	1894—	32,298 tons	1915—	56,026 tons
1874—	94,708 tons	1895—	42,186 tons	1916—	
1875—	87,283 tons	1896—	80,710 tons	1917—	47,836 tons
1876—	98,480 tons	1897—	79,102 tons	1918—	15,879 tons
1877—	80,340 tons	1898—	55,012 tons	1919—	56,840 tons

Total, tons 4,226,655

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

South Jackson:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
39.46	.050	34.90	2.90	1.91	.35	.29	.014	2.32

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
7.42	36.53	.046	32.31

LAKE MINE

Location: Marquette county, Mich., Section 10, Township 47, Range 27.

Description: First opened up in 1888. The ore is a soft, red, nonbessemer hematite. The mine is worked by the caving system, the greatest vertical depth being 613 feet. The ore is shipped via the L. S. & I. and the D., S. S. & A. railroads to Marquette, Mich., and the C. & N. W. to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: L. Eaton.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1892—188,439	tons	1902—448,427	tons	1912—495,651	tons
1893—162,700	tons	1903—456,514	tons	1913—517,059	tons
1894— 94,715	tons	1904—399,521	tons	1914—317,110	tons
1895—160,790	tons	1905—568,568	tons	1915—316,902	tons
1896—162,326	tons	1906—600,002	tons	1916—463,374	tons
1897—339,521	tons	1907—552,530	tons	1917—477,174	tons
1898—386,088	tons	1908—250,252	tons	1918—399,929	tons
1899—464,549	tons	1909—463,478	tons	1919—234,143	tons
1900—457,453	tons	1910—244,923	tons		
1901—406,783	tons	1911—166,850	tons		

Total, tons 10,195,909

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Lake:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.60	.139	5.57	.73	3.02	.64	.88	.014	3.58

Lake Bessemer:

61.05	.039	8.24	.22	1.84	.50	.26	.010	2.16

The ore in its natural state is as follows:

Lake:

Moist.	Iron	Phos.	Silica
12.50	52.15	.122	4.87

Lake Bessemer:

12.00	53.72	.034	7.25

LAKE SUPERIOR (Hard)

Location: Marquette county, Mich., Sections 9, 10 and 16, Township 47, Range 27.

Description: First opened up in 1857. This mine ships four grades of ore: ABBOTSFORD and CASTLEGUARD, hard, blue bessemer hematites; CASTLEFORD, a hard, blue nonbessemer hematite and HEMATITE BEDFORD, a hard and soft, red nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 1,247 feet. The ore is shipped via the D. S. S. & A., L. S. & I. and C. & N. W. railroads to Marquette and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ishpeming, Mich.

General Manager: J. H. McLean.

Superintendent: F. E. Keese.

Yearly Shipments:

Lake Superior (Hard and Soft)

1857—		1878—109,674	tons	1899—682,595	tons
1858— 4,658	tons	1879—173,938	tons	1900—709,143	tons
1859— 24,668	tons	1880—204,094	tons	1901—635,642	tons
1860— 33,015	tons	1881—262,235	tons	1902—832,796	tons
1861— 25,195	tons	1882—296,509	tons	1903—604,829	tons
1862— 37,709	tons	1883—200,799	tons	1904—590,339	tons
1863— 78,976	tons	1884—204,796	tons	1905—727,378	tons
1864— 86,773	tons	1885—226,040	tons	1906—635,671	tons
1865— 55,201	tons	1886—267,622	tons	1907—674,066	tons
1866— 68,002	tons	1887—302,909	tons	1908—261,955	tons
1867—119,935	tons	1888—240,225	tons	1909—349,435	tons
1868—105,745	tons	1889—288,784	tons	1910—271,455	tons
1869—135,560	tons	1890—318,321	tons	1911—174,959	tons
1870—166,582	tons	1891—308,831	tons	1912—219,673	tons
1871—158,047	tons	1892—366,715	tons	1913—203,964	tons
1872—195,617	tons	1893—329,610	tons	1914— 89,957	tons
1873—158,428	tons	1894—344,758	tons	1915—199,920	tons
1874—124,311	tons	1895—342,439	tons	1916—422,525	tons
1875—129,365	tons	1896—459,576	tons	1917—312,459	tons
1876—111,379	tons	1897—376,761	tons	1918—345,708	tons
1877—127,349	tons	1898—686,563	tons	1919—274,470	tons

Total, tons 17,473,643

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Abbotsford:

Iron	Phos.	Silica	Mang.
61.61	.031	8.00	.110

Bedford:

57.29	.082	10.45	.220

Castleford:

53.73	.065	17.81	.110

The ore in its natural state is as follows:

Abbotsford:

Moist.	Iron	Phos.	Silica
3.77	59.29	.030	7.69

Bedford:

10.77	51.12	.073	9.33

Castleford:

2.61	52.33	.064	17.35

LAKE SUPERIOR (Soft)

Location: Marquette county, Mich., Sections 10 and 21, Township 47, Range 27.

Description: First opened up in 1857. This mine ships two grades of ore: CASTLEGUARD, a hard, blue bessemer hematite, and BEDFORD, a soft, red nonbessemer hematite. The mine is worked by the underground system, the greatest vertical depth being 895 feet. The ore is shipped via the D. S. S. & A., L. S. & I., and the C. & N. W. railroads to Marquette and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ishpeming, Mich.

General Manager: J. H. McLean.

General Superintendent: F. E. Keese.

Yearly Shipments: See Lake Superior (Hard).

Analysis: See analyses of BEDFORD and CASTLEGUARD.

LILLIE MINE

Location: Marquette county, Mich., Section 35, Township 48, Range 27.

Description: First opened up in 1875. The ore is a hard, brown nonbessemer hematite. The mine is worked by the stoping system, the greatest vertical depth being 1,000 feet. This property is included in the Cambria-Hartford properties, Negaunee, Mich., and is not operated as the Lillie. The ore is shipped via the C. & N. W. and the D., S. S. & A. railroads to Escanaba and Marquette respectively, and thence by boat to the lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, O.

Manager: F. J. Webb.

Superintendent: J. E. Nelson.

Yearly Shipments:

1875—	144	tons	1888—	32,692	tons	1901— 98,788	tons
1876—	5,801	tons	1889—	33,916	tons	1902— 79,919	tons
1877—	10,127	tons	1890—	31,812	tons	1903— 77,454	tons
1878—	8,506	tons	1891—	19,551	tons	1904— 63,209	tons
1879—	22,380	tons	1892—	29,005	tons	1905— 9,868	tons
1880—	18,347	tons	1893—	68,861	tons	1906— 32,781	tons
1881—	16,748	tons	1894—	78,388	tons	1907— 80,545	tons
1882—	27,494	tons	1895—	54,285	tons	1908— 8,632	tons
1883—	4,614	tons	1896—	107,532	tons	1909— 61,708	tons
1884—	2,683	tons	1897—	112,781	tons	1910— 10,121	tons
1885—	708	tons	1898—	211,023	tons	1911— 844	tons
1886—	3,957	tons	1899—	196,200	tons	1912— 109,584	tons
1887—	23,041	tons	1900—	114,990	tons		

Total, tons 1,869,003

LLOYD MINE

Location: Marquette county, Mich., Section 6, Township 47, Range 27.

Description: First opened up in 1909. This mine ships two grades of ore: LLOYD, a soft, red nonbessemer hematite, and LLOYD SILICA, a soft, red siliceous hematite. The mine is worked by the open-pit, caving and shrinkage stope systems, the greatest vertical depth being 875 feet. The ore is shipped via the L. S. & I. railroad to Presque Isle and Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: J. M. Bush.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1911— 28,003 tons	1914—123,211 tons	1917—192,332 tons
1912— 44,467 tons	1915—195,975 tons	1918—263,254 tons
1913—135,746 tons	1916—281,502 tons	1919—173,438 tons

Total, tons 1,437,928

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Lloyd:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.95	.089	6.75	.25	2.43	.95	.30	.013	4.88

Lloyd Silica:

51.83	.070	17.16	.25	2.58	.87	.31	.013	4.51

The ore in its natural state is as follows:

Lloyd:

Moist.	Iron	Phos.	Silica
11.40	52.23	.079	5.98

Lloyd Silica:

10.40	46.44	.063	15.37

LUCY MINE

Location: Marquette county, Mich., Sections 6 and 7, Township 47, Range 26.

Description: First opened up in 1878, but is now idle.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: G. R. Jackson.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1878— 30,180 tons	1889— 32,982 tons	1908— 1,115 tons
1879— 28,962 tons	1890— 43,483 tons	1909— 1,672 tons
1880— 31,206 tons	1891— 27,683 tons	1910— 11,257 tons
1881— 28,051 tons	1892— 26,326 tons	1911— 16,677 tons
1882— 40,406 tons	1893— 21,964 tons	1912— 73,120 tons
1883— 14,676 tons	1897— 10,033 tons	1913— 2,025 tons
1887— 12,139 tons	1898— 11,846 tons	
1888— 22,276 tons	1906— 85 tons	

Total, tons 622,110

MACKINAW MINE

Location: Marquette county, Mich., Section 35, Township 45, Range 25.

Description: Development commenced in 1911. The ore is shipped via the M., M. & S. E. railroad to Escanaba and Presque Isle, Mich., and thence by boat to the lower lake ports. The shaft is 862 feet deep.

Operating Company: The Cleveland-Cliffs Iron Co., Gwinn, Mich.

Manager: M. M. Duncan.

Superintendent: W. W. Graff.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Shipments:

1919— 32,332 tons

Total, tons 32,332

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

The ore in its natural state is as follows:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.38	.090	3.71						

Moist.	Iron	Phos.	Silica
8.06	55.51	.083	3.41

MAITLAND MINE (Formerly Volunteer)

Location: Marquette county, Mich., W½ of N. W. ¼ Section 30, Township 47, Range 26.

Description: First opened up in 1871. This property is now operated as an open-pit silicious ore mine by Alexander Maitland, Negaunee, Mich., the name of the ore being SCOTT.

Manager: A. F. Maitland.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1871— 4,171	tons	1887— 47,486	tons	1903— 7,395	tons
1872— 40,655	tons	1888— 56,321	tons	1904— 71,870	tons
1873— 50,418	tons	1889— 60,156	tons	1905—106,281	tons
1874— 19,560	tons	1890—141,524	tons	1906— 38,544	tons
1875— 4,070	tons	1891— 92,699	tons	1907— 10,022	tons
1876— 15,324	tons	1892—127,130	tons	1910—	
1877— 20,211	tons	1893— 69,561	tons	1911— 51,240	tons
1878— 5,929	tons	1894— 26,946	tons	1912— 9,608	tons
1879— 24,663	tons	1895— 32,672	tons	1913— 47,698	tons
1880— 38,881	tons	1896— 53,216	tons	1914— 38,818	tons
1881— 39,276	tons	1897— 1,617	tons	1915— 18,850	tons
1882— 41,456	tons	1898—		1916—106,988	tons
1883— 19,414	tons	1899— 29,983	tons	1917— .	
1884— 11,748	tons	1900— 47,578	tons	1918— 19,625	tons
1885— 5,679	tons	1901—		1919— 56,506	tons
1886— 24,034	tons	1902— 32,736	tons		

Total, tons 1,748,305

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
45.14	.065	30.56	.16	1.21	.42	.58	.012	2.40

The ore in its natural state is as follows:

Moist.	Iron	Phos	Silica
4.36	43.17	.062	29.23

MARY CHARLOTTE No. 1 MINE

Location: Marquette county, Mich., Section 8, Township 47 N., Range 26 W.

Description: First opened up in 1903. This mine ships two ores: MARY and CHARLOTTE, both soft, red, nonbessemer hematites. The mine is worked by the caving and stoping methods, the greatest vertical depth being 640 feet. The ore shipped via the D. S. S. & A., L. S. & I. and C. & N. W railroads to Marquette and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Mary Charlotte Mining Co., Negaunee, Mich.

Manager: C. B. Dunster, Cleveland, O.

Superintendent: W. B. Pattison, Negaunee, Mich.

Sales Agents: E. N. Breitung & Co., Cleveland, O.

Yearly Shipments:

1903— 34,303	tons	1909—240,433	tons	1915—203,932	tons
1904— 48,885	tons	1910—197,522	tons	1916—228,374	tons
1905—221,738	tons	1911—343,434	tons	1917—247,854	tons
1906—257,088	tons	1912—260,801	tons	1918—273,650	tons
1907—155,633	tons	1913—264,120	tons	1919—231,420	tons
1908— 99,104	tons	1914— 69,056	tons		

Total, tons 3,377,337

Analysis: See analysis of MARY and CHARLOTTE.

MARY CHARLOTTE No. 2 MINE

Location: Marquette county, Mich., Section 8, Township 47 N., Range 26 W.

Description: First opened up in 1908. This mine ships two grades of ore: MARY and CHARLOTTE, both soft, red, nonbessemer hematites. The mine is worked by the caving and stoping systems, the greatest vertical depth being 640 feet. The ore is shipped via the D., S. S. & A., L. S. & I. to Marquette, Mich., and the C. & N. W. to Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: The Mary Charlotte Mining Co., Negaunee, Mich.

Manager: C. B. Dunster, Cleveland, O.

Superintendent: W. B. Pattison, Negaunee, Mich.

Sales Agents: E. N. Breitung & Co., Cleveland, O.

Analysis: See analysis of MARY and CHARLOTTE.

MAAS MINE

Location: Marquette county, Mich., Sections 31 and 32, Township 48, Range 26, and Sections 5 and 6, Township 47, Range 26.

Description: First opened up in 1902. This mine ships two grades of ore: MAAS BESSEMER, soft, red bessemer hematite, and MAAS, a soft, red nonbessemer hematite. The mine is worked by the caving system, the greatest vertical depth being 1,375 feet. The ore is shipped via the L. S. & I. railroad to Presque Isle and Escanaba, Mich., and thence by boat to the lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: G. R. Jackson.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

1907— 32,378	tons	1912— 46,249	tons	1917—313,399	tons
1908— 29,036	tons	1913—170,705	tons	1918—354,709	tons
1909—159,197	tons	1914— 55,903	tons	1919—241,059	tons
1910—208,103	tons	1915—267,190	tons		
1911— 24,927	tons	1916—267,946	tons		

Total, tons 2,170,801

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Maas:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.10	.088	8.84	.30	2.19	.96	.28	.014	2.42

Maas Bessemer:

60.30	.043	9.30	.27	1.88	.63	.22	.007	1.50

The ore in its natural state is as follows:

Maas:

Moist.	Iron	Phos.	Silica
11.40	52.36	.078	7.83

Maas Bessemer:

12.00	53.06	.038	8.18

MILWAUKEE-DAVIS MINE

Location: Marquette county, Mich., Section 7, Township 47 N., Range 26 W.

Description: First opened up in 1879, but is now abandoned.

Operating Company: Breitung Hematite Mining Co., Ltd., Negaunee, Mich.

Manager: C. B. Dunster, Cleveland, O.

Superintendent: W. B. Pattison, Negaunee, Mich.

Sales Agents: E. N. Breitung & Co., Cleveland, O.

MORRIS MINE

Location: Marquette county, Mich., Section 1, Township 47, Range 28.

Description: First opened up in 1909. This mine ships three grades of ore: MORRIS BESSEMER, a soft, red, bessemer hematite; MORRIS, a soft red, nonbessemer hematite, and LLOYD SILICA, a soft, red, siliceous hematite.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming.

Yearly Shipments:

1912— 1,286 tons	1915— 80,546 tons	1918— 52,286 tons
1913— 18,394 tons	1916— 58,101 tons	1919— 17,119 tons
1914— 29,063 tons	1917— 94,708 tons	

Total, tons 351,503

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Morris Bessemer:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
60.00	.049	6.85	.22	2.05	.53	.23	.012	4.10

Morris:

58.45	.064	7.39	.25	2.43	.85	.30	.013	4.95

Lloyd Silica:

51.83	.070	17.16	.25	2.58	.87	.31	.013	4.51

The ore in its natural state is as follows:

Morris Bessemer:

Moist.	Iron	Phos.	Silica
11.40	53.16	.043	6.07

Morris:

11.40	51.79	.057	6.55

Lloyd Silica:

10.40	46.44	.063	15.37

NEGAUNEE MINE

Location: Marquette county, Mich., Sections 5 and 6, Township 47, Range 26.

Description: First opened up in 1887. This mine ships two grades of ore: NEGAUNEE BESSEMER, a soft, red, bessemer hematite, and NEGAUNEE, a soft, red nonbessemer hematite. The mine is worked by the caving system, the greatest vertical depth being 1086 feet. The ore is shipped via L. S. & I. railway to Marquette and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Negaunee Mine, Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: G. R. Jackson.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O., and Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

1887— 5,259	tons	1898—191,330	tons	1909—312,217	tons
1888— 45,304	tons	1899—195,573	tons	1910—348,818	tons
1889— 78,318	tons	1900—126,829	tons	1911—140,406	tons
1890— 76,488	tons	1901—234,713	tons	1912—446,318	tons
1891— 64,218	tons	1902—204,286	tons	1913—326,877	tons
1892— 85,846	tons	1903—224,665	tons	1914—247,484	tons
1893— 69,732	tons	1904—145,132	tons	1915—480,521	tons
1894—132,581	tons	1905—239,554	tons	1916—523,736	tons
1895— 90,682	tons	1906—253,488	tons	1917—533,760	tons
1896—175,394	tons	1907—296,170	tons	1918—501,965	tons
1897—182,169	tons	1908—232,219	tons	1919—411,296	tons

Total tons 7,663,308

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Negaunee:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.10	.094	7.70	.32	2.64	.90	.31	.009	3.10

Negaunee Bessemer:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
61.10	.048	6.29	.30	2.35	1.02	.36	.011	2.06

The ore in its natural state is as follows:

Negaunee:

Moist.	Iron	Phos.	Silica
11.50	52.30	.083	6.81

Negaunee Bessemer:

Moist.	Iron	Phos.	Silica
11.00	54.38	.043	5.60

OGDEN MINE

Location: Marquette county, Mich., Section 13, Township 47, Range 27.

Description: First opened up in 1897. Operations were suspended in 1902.

Yearly Shipments:

Prior to 1898—986	tons	1899— 27,345	tons	1901— 10,642	tons
1898— 50,833	tons	1900— 15,325	tons	1902— 4,621	tons

Total, tons 109,752

PRINCETON MINE

Location: Marquette county, Mich., Sections 18 and 20, Township 45, Range 25.

Description: First opened up in 1872. The product of this mine is shipped as Group ore, CAMBRIDGE and STEPHENSON. The mine is worked by the caving system, the greatest vertical depth being 556 feet. The ore is shipped via the M., M. & S. E. and C. & N. W. railroads to Presque Isle and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Gwinn, Mich.

Manager: M. M. Duncan.

Superintendent: W. W. Graff.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

Swanzey and Cheshire Combined			1885—			1904— 76,461	tons
			1886— 8,328	tons		1905—129,079	tons
1872— 13,444	tons		1887— 2,842	tons		1906—166,894	tons
1873— 9,329	tons		**Princeton**			1907—177,863	tons
1874—			1891— 7,301	tons		1908— 36,033	tons
1875— 188	tons		1892— 29,403	tons		1909— 42,934	tons
1876— 225	tons		1893— 19,096	tons		1910— 89,441	tons
1877— 8,433	tons		1894—			1911— 27,962	tons
1878— 16,924	tons		1895— 6,593	tons		1912—162,138	tons
1879— 17,985	tons		1896—			1913— 53,476	tons
1880— 13,202	tons		1897—			1914— 13,607	tons
1881— 5,674	tons		1898— 25,247	tons		1915— 17,171	tons
Swanzey			1899— 55,802	tons		1916—	
1881— 9,337	tons		1900— 75,037	tons		1917—150,375	tons
1882— 31,498	tons		1901— 67,051	tons		1918— 66,243	tons
1883— 13,730	tons		1902—118,048	tons		1919—111,617	tons
1884— 3,557	tons		1903— 84,223	tons			

Total, tons 1,852,174

Analysis: See analyses of CAMBRIGE and STEPHENSON.

PORTLAND MINE

Location: Baraga county, Mich., N. ½ of N. W. ¼ of Section 26, Township 48 N., Range 31 W.

Description: First opened up in 1909, but is now idle.

Yearly Shipments:

1909— 79,552	tons		1912—			1915— 97,476	tons
1910— 49,584	tons		1913—				
1911—			1914— 45,324	tons			

Total, tons 272,036

QUEEN MINE

Location: Marquette county, Mich., Section 5, Township 47, Range 26.

Description: First opened up in 1888, but the mine is practically exhausted. The shipments shown include those from the Queen Group which included Buffalo, Prince of Wales, Queen and South Buffalo.

Operating Company: Oliver Iron Mining Co., Negaunee, Mich.
General Manager: J. H. McLean.
Superintendent: F. E. Keese.
Yearly Shipments:

1888— 5,527	tons	1899—342,978	tons	1910—230,119	tons
1889— 66,122	tons	1900—398,298	tons	1911—297,675	tons
1890—141,632	tons	1901—400,845	tons	1912—351,916	tons
1891—479,509	tons	1902—418,044	tons	1913—298,504	tons
1892—379,719	tons	1903—254,658	tons	1914—178,574	tons
1893—106,864	tons	1904—311,479	tons	1915—473,961	tons
1894—220,298	tons	1905—253,377	tons	1916—283,775	tons
1895—160,817	tons	1906—221,096	tons	1917— 88,178	tons
1896—323,057	tons	1907—309,917	tons	1918—	
1897—239,774	tons	1908—104,098	tons	1919—	
1898— 61,022	tons	1909—237,509	tons		

Total, tons 8,195,123

REPUBLIC MINE

Location: Marquette county, Mich., Section 7, Township 46, Range 29.

Description: First opened up in 1871. This mine ships five grades of ore: REPUBLIC BESSEMER CRUSHED and REPUBLIC BESSEMER LUMP, hard, blue, bessemer speculars; REPUBLIC BASIC CRUSHED, REPUBLIC BASIC LUMP, and PASCOE, hard, blue, nonbessemer speculars. The mine is worked by the open stoping and shrinkage stope systems, the greatest vertical depth being 2,470 feet. The ore is shipped via the C. & N. W., C., M. & St. P. and the D., S. S. & A. railroads to Presque Isle, Mich., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Republic, Mich.
Manager: M. M. Duncan.
Superintendent: C. J. Stakel.
Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.
Yearly Shipments:

1872— 11,025	tons	1888—235,062	tons	1904—124,506	tons
1873—105,453	tons	1889—287,390	tons	1905—150,699	tons
1874—122,639	tons	1890—220,065	tons	1906—177,220	tons
1875—119,726	tons	1891—191,127	tons	1907—170,554	tons
1876—120,095	tons	1892—167,991	tons	1908— 67,999	tons
1877—165,836	tons	1893— 64,195	tons	1909—176,575	tons
1878—176,221	tons	1894—105,719	tons	1910—150,732	tons
1879—135,231	tons	1895—174,027	tons	1911—113,012	tons
1880—235,387	tons	1896—127,360	tons	1912—156,864	tons
1881—233,786	tons	1897—124,342	tons	1913—137,063	tons
1882—235,109	tons	1898—140,312	tons	1914— 52,562	tons
1883—152,565	tons	1899—137,085	tons	1915—215,182	tons
1884—277,757	tons	1900—130,126	tons	1916—209,060	tons
1885—250,835	tons	1901—104,604	tons	1917—168,250	tons
1886—241,161	tons	1902—157,646	tons	1918—151,170	tons
1887—220,624	tons	1903—155,415	tons	1919— 69,035	tons

Total, tons 7,616,401

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Republic Basic Lump:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
63.50	.060	6.62	.02	1.04	.54	.28	.008	.28

Republic Basic Crushed:

61.57	.066	8.60	.04	1.75	.34	.33	.008	.45

Republic Bessemer Lump:

64.00	.040	5.75	.05	1.29	.65	.40	.008	.06

Republic Bessemer Crushed:

63.18	.040	7.80	.04	1.71	.70	.33	.008	.09

Pascoe:

55.79	.053	17.65	.03	1.76	.25	.55	.010	.14

The ore in its natural state is as follows:

Republic Basic Lump:

Moist.	Iron	Phos.	Silica
.25	63.34	.059	6.60

Republic Basic Crushed:

1.35	60.74	.065	8.48

Republic Bessemer Lump:

.25	63.84	.040	5.73

Republic Bessemer Crushed:

1.25	62.39	.039	7.70

Pascoe:

.80	55.34	.053	17.50

RICHMOND MINE

Location: Marquette county, Mich., Section 28, Township 47, Range 26.

Description: First opened up in 1896. The ore is a hard, red, silicious hematite, and is crushed. The mine is worked by the open-pit system. The ore is shipped via the C. & N. W. railroad to Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: Richmond Iron Company, Palmer, Mich.

Manager: Earl E. Hunner.

Superintendent: John Huhtala.

Sales Agents: M. A. Hanna & Co., Cleveland, O.

Yearly Shipments:

1896—	1,088	tons	1904—	68,134	tons	1912—	118,554	tons
1897—	4,630	tons	1905—	86,129	tons	1913—	138,394	tons
1898—	24,464	tons	1906—	89,563	tons	1914—	129,548	tons
1899—	4,613	tons	1907—	35,156	tons	1915—	177,000	tons
1900—	51,303	tons	1908—	60,994	tons	1916—	181,154	tons
1901—	54,181	tons	1909—	102,566	tons	1917—	148,834	tons
1902—	50,041	tons	1910—	95,772	tons	1918—	144,104	tons
1903—	55,593	tons	1911—	47,586	tons	1919—	160,006	tons

Total, tons 2,029,407

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
40.62	.047	38.17	.14	1.12	.43	.39	.011	1.81

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
3.34	39.26	.045	36.90

ROLLING MILL MINE

Location: Marquette county, Mich., Section 7, Township 47, Range 26.

Description: First opened up in 1872. This mine ships four grades of ore: ROLLING MILL No. 1, ROLLING MILL No. 3, SILVERY, and ROLLING MILL SILICEOUS, soft, brown nonbessemer hematites of coarse structure. The mine is worked by underground methods for the three first-named ores, and by open-pit steam-shovel mining for the ROLLING MILL siliceous grade. The greatest vertical depth is 786 feet. The ore is shipped via the L. S. & I. and the D. S. S. & A. railroad to Marquette, and via the C. N. W. to Escanaba, thence by boat to lower lake ports.

Operating Company: Rolling Mill Mining Co., Alworth Bldg., Duluth, Minn.

Manager: R. S. Archibald.

General Superintendent: Edward P. Scallon.

Sales Agents: Clement K. Quinn & Company, Alworth Bldg., Duluth, Minn., and Cleveland.

Yearly Shipments:

1872—	6,772	tons	1886—	4,403	tons	1908—	52,147	tons
1873—	11,319	tons	1887—	1,058	tons	1909—	133,139	tons
1874—	16,643	tons	1888—	402	tons	1910—	115,193	tons
1875—	37,806	tons	1897—	3,975	tons	1911—	96,585	tons
1876—	53,265	tons	1898—			1912—	115,784	tons
1877—	38,121	tons	1899—			1913—	163,286	tons
1878—	30,773	tons	1900—	22,585	tons	1914—	98,010	tons
1879—	10,039	tons	1901—	22,815	tons	1915—	130,902	tons
1880—	15,172	tons	1902—	24,874	tons	1916—	253,943	tons
1881—	1,668	tons	1903—	6,786	tons	1917—		
1882—	163	tons	1904—			1918—		
1883—	1,528	tons	1905—	28,766	tons	1919—	116,389	tons
1884—	1,820	tons	1906—					
1885—	3,437	tons	1907—	49,204	tons			

Total, tons 1,668,771

Analysis: Dried at 212 degrees Fahr.

Rolling Mill No. 1:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.66	.117	7.92	.43	2.98	1.33	1.21	.075	2.80

Rolling Mill No. 3:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.80	.116	8.02	.44	3.12	1.35	1.20	.200	2.78

Silvery:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
50.50	.086	16.05	.54	3.10	2.45	1.15	.871	2.40

Rolling Mill Siliceous:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
41.50	.076	36.47	32	2.52	1.32	.67	.020	2.14

The ore in its natural state is as follows:

Rolling Mill No. 1:

Moist.	Iron	Phos.	Silica
13.45	51.63	.101	6.85

Rolling Mill No. 3:

Moist.	Iron	Phos.	Silica
13.05	51.13	.101	6.97

Silvery:

Moist.	Iron	Phos.	Silica
12.50	44.19	.075	14.04

Rolling Mill Siliceous:

Moist.	Iron	Phos.	Silica
6.25	38.90	.071	34.19

SALISBURY MINE

Location: Marquette county, Mich., Section 15, Township 47, Range 27.

Description: First opened up in 1872. This mine ships four grades of ore: SALISBURY BESSEMER and SALISBURY, soft, red bessemer hematites; CLINTON, a soft, red nonbessemer hematite, and CLINTON SILICA, a soft, red siliceous hematite. The mine is worked by the caving system, the greatest vertical depth being 1,120 feet. The ore is shipped via the L. S. & I., C. & N. W. and the D., S. S. & A. railroads to Presque Isle and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent:. L. Eaton.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.

Yearly Shipments:

Salisbury							
1872—	545	tons	1881—	43,690	tons	1910—	85,098 tons
1873—	11,023	tons	1882—	42,243	tons	1911—	91,334 tons
1874—	6,730	tons	1883—	17,028	tons	1912—	161,068 tons
1875—	4,571	tons	1884—	26,629	tons	1913—	46,095 tons
1876—	20,510	tons	1885—	29,503	tons	1914—	69,090 tons
1877—	37,869	tons	1886—	51,667	tons	1915—	9,656 tons
1878—	52,155	tons	1887—	48,304	tons	1916—	107,212 tons
1879—	39,293	tons	1888—	74,947	tons	1917—	107,739 tons
1880—	21,457	tons	1889—	72,449	tons	1918—	221,803 tons
			1890—	85,798	tons	1919—	106,175 tons

Total, tons 1,691,590

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Salisbury:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.50	.089	7.85	.58	1.50	1.55	.91	.009	2.30

Salisbury Bessemer:

60.00	.046	9.40	.31	1.55	.14	.17	.016	2.65

Clinton:

60.30	.075	6.40	.19	2.64	.35	.21	.016	4.28

Clinton Silica:

50.70	.075	21.85	.19	1.63	.16	.20	.004	3.28

The ore in its natural state is as follows:

Salisbury:

Moist.	Iron	Phos.	Silica
13.50	51.47	.077	6.79

Salisbury Bessemer:

4.50	51.30	.039	8.04

Clinton:

13.50	52.16	.065	5.54

Clinton Silica:

11.30	44.97	.066	19.38

STAR WEST MINE (Formerly Wheat Mine)

Location: Marquette county, Mich., Section 29, Township 47, Range 26.

Description: First opened up in 1879, but is now idle.

Yearly Shipments:

1879—	851	tons	1889—	7,997	tons	1899—	6,716	tons
1880—	3,323	tons	1890—	15,141	tons	1900—	15,987	tons
1881—	9,040	tons	1891—	4,412	tons	1911—	4,466	tons
1882—	9,554	tons	1892—			1912—		
1883—	6,625	tons	1893—			1913—		
1884—	6,824	tons	1894—	5,550	tons	1914—		
1885—	9,200	tons	1895—	51,207	tons	1915—		
1886—	15,867	tons	1896—	9,658	tons	1916—		
1887—	17,538	tons	1897—	942	tons			
1888—	4,987	tons	1898—					

Total, tons 209,115

STEGMILLER MINE

Location: Marquette county, Mich., Section 17, Township 45, Range 25.

Description: First opened up in 1909, but is now exhausted.

Yearly Shipments:

1909—	39,869	tons	1912—	50,963	tons	1915—	40,248	tons
1910—	48,842	tons	1913—	45,431	tons	1916—	65,420	tons
1911—	45,122	tons	1914—	40,972	tons	1917—	41,526	tons

Total, tons 418,393

STEPHENSON MINE

Location: Marquette county, Mich., Section 20, Township 45, Range 25.

Description: First opened up in 1904. This mine ships three grades of ore: STEPHENSON BESSEMER, a soft, red, bessemer hematite; STEPHENSON, and CAMBRIDGE, both soft, red, nonbessemer hematite. The mine is worked

by the caving system, the greatest vertical depth being 604 feet. The ore is shipped via the C. & N. W. railway and the M., M. & S. E. railway to Presque Isle and Escanaba, Mich., and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Gwinn, Mich.
Manager: M. M. Duncan.
Superintendent: W. W. Graff.
Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.
Yearly Shipments:

1907— 6,305 tons	1912—214,386 tons	1917—496,713 tons
1908— 52,588 tons	1913— 96,279 tons	1918— 75,164 tons
1909— 64,075 tons	1914— 93,795 tons	1919— 1,965 tons
1910—225,726 tons	1915—243,458 tons	
1911—128,839 tons	1916—355,166 tons	

Total tons..... 2,054,457

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Stephenson:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.10	.221	7.27	.44	2.64	1.31	1.16	.031	1.98

Stephenson Bessemer:

61.50	.043	5.83

Cambridge:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
58.40	.690	4.83	.61	2.33	1.69	.60	.049	4.54

The ore in its natural state is as follows:

Stephenson:

Moist.	Iron	Phos.	Silica
13.55	51.09	.191	6.28

Stephenson Bessemer:

Moist.	Iron	Phos.	Silica
14.50	52.58	.045	4.98

Cambridge:

Moist.	Iron	Phos.	Silica
11.00	51.98	.614	4.30

WASHINGTON MINE (Humbolt)

Location: Marquette county, Mich., Section 11, Township 47 N., Range 29 W.

Description: First opened up in 1860. This mine ships four grades of ore: WASHINGTON No. 1, WASHINGTON No. 2, WASHINGTON SILICEOUS and WASHINGTON LUMP, all hard, steel-gray, nonbessemer, specular and magnetite ores, crushed. The mine is worked by the stoping method, the greatest vertical depth being 730 feet. The ore is shipped via the D., S. S. & A. railroad to Marquette, Mich., and thence by boat to the lower lake ports.

Operating Company: Washington Iron Co., Humbolt, Mich.
Manager: C. B. Dunster, Cleveland, O.

Superintendent: W. B. Pattison, Negaunee, Mich.

Sales Agents: E. N. Breitung & Co., Cleveland, O.

Yearly Shipments:

Humbolt			1874—	27,890	tons	1884—	23,763	tons
1865—	4,782	tons	1875—	9,642	tons	1885—	11,766	tons
1866—	15,150	tons	1876—	3,333	tons	1886—	20,207	tons
1867—	25,440	tons	1877—	16,545	tons	1887—	19,873	tons
1868—	35,757	tons	1878—	33,920	tons	1888—	11,655	tons
1869—	58,462	tons	1879—	18,204	tons	1889—	15,866	tons
1870—	79,762	tons	1880—	14,726	tons	1890—	23,259	tons
1871—	48,725	tons	1881—	26,302	tons	1891—	19,879	tons
1872—	38,841	tons	1882—	43,463	tons	1892—	4,571	tons
1873—	38,014	tons	1883—	31,866	tons	1896—	2,297	tons
Total, tons							723,961	
Washington			1911—	62,592	tons	1915—		
1908—	20,625	tons	1912—	66,749	tons	1916—	6,631	tons
1909—	44,716	tons	1913—	60,581	tons	1917—	12,605	tons
1910—	96,769	tons	1914—	1,659	tons			
Total, tons							372,927	

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Washington:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
59.91	.145	9.98	.06	1.33	.60	.25	.019	.08

The ore in its natural state is as follows:

Washington:

Moist.	Iron	Phos.	Silica
.94	59.35	.143	9.88

WEBSTER MINE

Location: Baraga county, Mich., Section 26, Township 48, Range 31.

Description: First opened up in 1882. The ore is a soft, brown, nonbessemer limonite. Operations were suspended in 1900.

Operating Company: Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, O.; Pickands, Mather & Co., Cleveland, O.

Yearly Shipments:

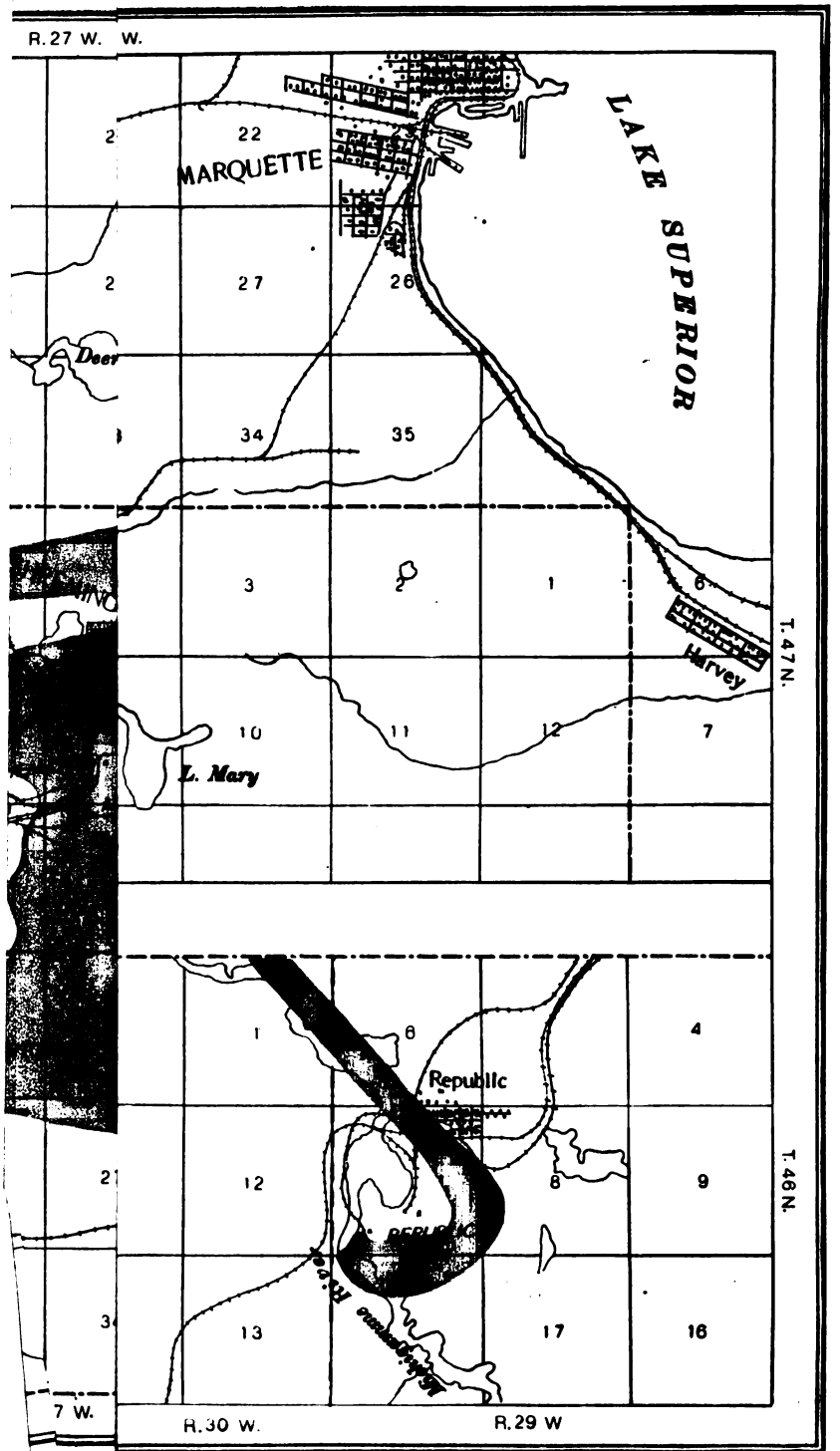
1882—	4,443	tons	1885—			1888—		
1883—	934	tons	1886—	6,229	tons	1889—	448	tons
1884—			1887—	2,054	tons			
Total, tons							34,905	

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
52.00	.330	10.00	.28	.63	3.28	.23	.058	8.35

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.60	46.49	.295	8.94


R.27 W.
W.
LAKE SUPERIOR
MARQUETTE
22
27
26
Deer
34
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3
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Harvey
T.47N.
10
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7
L. Mary
1
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4
Republic
12
8
9
T.46N.
13
17
16
7 W.
R.30 W.
R.29 W

BARABOO DISTRICT

ILLINOIS MINE

Location: Sauk county, Wis., Section 15 and 16, Township 11 North, Range 5 East.

Description: First opened up in 1904, but is now idle.

Yearly Shipments:

1904— 47,922 tons	1906— 67,118 tons	1908— 51,108 tons
1905— 71,413 tons	1907— 72,180 tons	1916— 5,609 tons

Total, tons 315,350

MAYVILLE DISTRICT

IRON RIDGE MINE

Location: Dodge county, Wis., Sections 1, 12, 13, 16 and 36, Townships 11 and 12, Range 16.

Description: First opened up in 1903. The ore was a soft, yellowish-brown nonbessemer hematite. The mine is now inactive.

Yearly Shipments:

1903— 17,913 tons	1907— 3,966 tons	1911— 17,002 tons
1904— 19,558 tons	1908—	1912— 19,284 tons
1905— 39,978 tons	1909— 15,955 tons	1913— 26,213 tons
1906— 61,634 tons	1910— 14,487 tons	1914— 2,216 tons

Total, tons 238,196

MAYVILLE MINE

Location: Dodge county, Wis., Section 12, Township 11, Range 16.

Description: First opened up in 1893. The ore is a soft, red nonbessemer hematite, and is crushed. The mine is worked by the underground method, the greatest vertical depth being 125 feet. The ore is shipped via the C., M. & St. P. railroad to the Mayville Furnace Co.

Operating Company: The Steel & Tube Co. of America, Milwaukee, Wis.

Manager: J. H. Means.

Superintendent: E. S. O'Connor.

Yearly Shipments:

Prior to 1893—9,044 tons

1893— 7,925 tons	1902— 23,338 tons	1911— 98,627 tons
1894— 10,511 tons	1903— 18,836 tons	1912— 84,737 tons
1895— 16,472 tons	1904— 26,562 tons	1913—118,797 tons
1896— 13,144 tons	1905— 20,610 tons	1914—103,549 tons
1897— 10,546 tons	1906— 15,847 tons	1915— 80,583 tons
1898— 18,151 tons	1907— 19,644 tons	1916—125,970 tons
1899— 19,731 tons	1908— 71,341 tons	1917— 93,997 tons
1900— 20,986 tons	1909— 66,804 tons	1918— 88,812 tons
1901— 22,400 tons	1910— 77,195 tons	1919— 92,849 tons

Total, tons 1,377,018

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Mang.	Silica	Alum.	Lime	Magnes.	Sul.	Loss
42.11	1.16	.08	4.52	3.80	7.44	4.82	.142	15.92

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
10.98	37.50	1.04	4.03

HELEN MINE

Location: District of Algoma, Michipicoten, Ont., Township 29, Range 24.

Description: First opened up in 1899, but is now worked out. The ore was a hard, brown nonbessemer hematite, and was crushed.

Operating Company: Algoma Steel Corp., Ltd., Sault Ste. Marie, Ont.

Secretary: Geo. S. Cowie, Sault Ste. Marie, Ont.

Yearly Shipments:

1900— 65,000 tons	1907—142,832 tons	1914— 80,860 tons
1901—232,531 tons	1908—148,421 tons	1915—220,771 tons
1902—302,510 tons	1909—170,065 tons	1916— 37,272 tons
1903—203,119 tons	1910—115,790 tons	1917— 88,606 tons
1904—118,355 tons	1911—148,627 tons	1918— 21,959 tons
1905—169,527 tons	1912— 48,838 tons	1919—none
1906—121,556 tons	1913— 42,550 tons	

Total, tons 2,479,189

MAGPIE MINE

Location: District of Algoma, Michipicoten, Ont., Township 29, Range 26.

Description: First opened up in 1911. The ore is a hard, black bessemer, roasted siderite, and is crushed. The mine is worked by back-stoping from sub-levels, the greatest vertical depth being 581 feet. The ore is shipped via the Algoma Central & Hudson Bay railroad to Michipicoten harbor, and thence by boat to lower lake ports.

Operating Company: Algoma Steel Corp., Ltd., Sault Ste. Marie, Ont.

Secretary: Geo. S. Cowie, Sault Ste. Marie, Ont.

Superintendent: Geo. R. McLaren.

Sales Agents: M. A. Hanna & Co., Agents, Cleveland, O.

Yearly Shipments:

1913— 19,934 tons	1916—187,966 tons	1919—163,008 tons
1914— 98,070 tons	1917—174,774 tons	
1915—118,697 tons	1918—157,095 tons	

Total, tons 919,544

Analysis: The average of all cargo analyses for 1919 is as follows: Dried at 212 degrees Fahr.

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
50.20	.029	9.28	2.52	1.90	7.70	6.79	.300	none

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
1.26	49.57	.029	9.16

MOOSE MOUNTAIN DISTRICT

MOOSE MOUNTAIN MINE

Location: Sellwood, Hutton township, 30 miles west of Sudbury, on the Canadian National railway.

Description: First opened in 1908. For several years produced cobbed ore, magnetite, and later, briquettes, which were made by the Grondal and a special process, crushed and screened, as the briquettes (bessemer) were rather soft. The mine was originally opened by shaft and open-pit system, the greatest vertical depth being about 150 feet. For the past two years the property has been worked through a tunnel 1200 feet in length, through which is mined a finely disseminated magnetite averaging about 35 per cent iron, and .08 per cent phosphorus. This ore is crushed to about 1½-inch ring, then ground in Marcy and Hardinge 8-foot ball mills to a fineness of 200 mesh, treated on Grondal wet magnetic separators, dewatered on Oliver continuous filters, making a concentrate averaging over 65 per cent iron, and less than .012 per cent in phosphorus. Concentrates are briquetted in special heavy-type presses, piled on flat-top cars, and run through kilns of the Grondal type, 250 feet long, with temperature at the combustion chamber about 2200 degrees Fahr., the resultant product being a hard, porous hematite briquette, 2¼ x 4 x 8 inches.

Operating Company: Moose Mountain, Ltd., Whitehall building, New York city.

Consulting Engineer and Sales Agents: W. Rowland Cox, Room 1834, 120 Broadway, New York city.

General Manager: A. J. Anderson, Sellwood, Ont.

Yearly Production:

1908— 2,557 tons	1912— 39,061 tons	1916— 5,338 tons
1909— 26,199 tons	1913—102,238 tons	1917—Not producing
1910— 71,784 tons	1914— 29,457 tons	1918— 26,777 tons
1911— 6,749 tons	1915— 40,444 tons	1919— 38,287 tons

Total, tons 388,891

Analysis: The expected analysis for 1920 is as follows:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sul.	Loss
64.00	.015	8.00	.08	.20	.43	.52	....	....

The ore in its natural state is as follows:

Moist.	Iron	Phos.	Silica
.....	64.00	.015	8.00

INDEX TO MINES AND ORES

Steam Shovels

Revolving and Railroad Types

¾ to 6 cu. yds. capacity

OSGOOD

OSGOOD 18
¾ Yard Traction Revolving Steam Shovel

The OSGOOD 18 is built along the same lines as the heavier and more powerful OSGOOD Shovels. It has horizontal hoisting engines, double geared shipper shaft, strong armored boom and dipper handle, machine cut gears, bronze bushings, etc. You should investigate this shovel, if interested in road grading, cellar excavating, sewer trenching, railroad work, working in gravel pits, brick and clay yards, stone quarries, coal mining, stripping, ditching, dredging, etc.

OSGOOD 18
¾ Yard Continuous Tread Revolving Steam Shovel

The many important and popular advantages that are characteristic of the OSGOOD Steam Shovels have now been further supplemented by the Continuous Tread mounting. These trucks are interchangeable with the traction wheels and are easily attached to the underside of the cast steel truck frame. The outfit is very compact so as to interfere as little as possible with the operation of the dipper.

OSGOOD 18
Equipped with ¾ Yard Clamshell Bucket

The OSGOOD 18 Clamshell outfit as shown, makes an ideal equipment for the loading or unloading of cars, the handling of sand, gravel, stone, coal, etc., to and from storage piles. It is regularly fitted with a 30-ft. boom, worm and gear raising and lowering device, and can be mounted on either railroad, traction or continuous tread trucks.

THE OSGOOD COMPANY,

(See following page)

(See following page)

(See following page)

(*See preceding page*)

Crowell & Murray

Organization

Benedict Crowell	Mining Engineer
C. B. Murray	Chemist & Metallurgist
H. E. Wetherbee	Mining Engineer
D. B. Miller	Mining Engineer
Titus Sheard	Chief Chemist
C. C. Walsh	In Charge of Sampling
H. E. Tamblyn	Chemist
George Yearly	Chemist
Carl Marshall	Cement Tester
N. P. Bishop	Accountant
Miss Leola Lewis	Stenographer

C. C. Walsh, Head Sampler	Cleveland, O.
W. H. Blowers, Head Sampler	Ashtabula Harbor, O.
J. H. Muskopf, Head Sampler	Buffalo, N. Y.
Louis Mango, Head Sampler	Erie, Pa.
C. P. Hartung, Head Sampler	Toledo, O.
F. M. Croft, Head Sampler	Detroit, Mich.
H. E. Allender, Head Sampler	Chicago, Ill.
W. J. Buckley, Head Sampler	Sault Ste. Marie, Ont.
H. C. Anderson, Head Sampler	Duluth, Minn.
George Foubister, Head Sampler	Point Edward, Ont.